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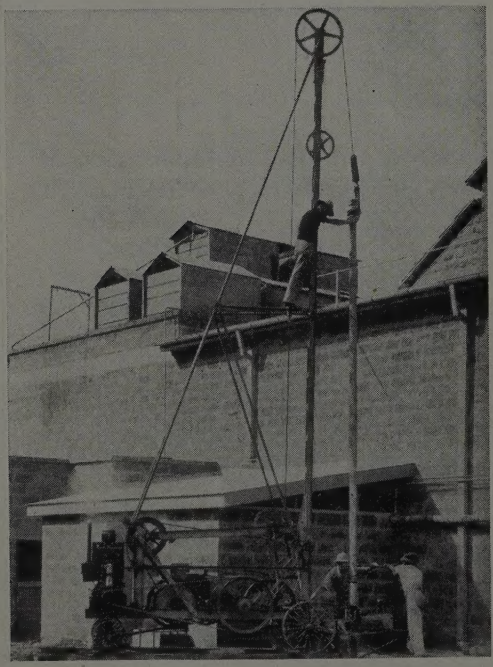

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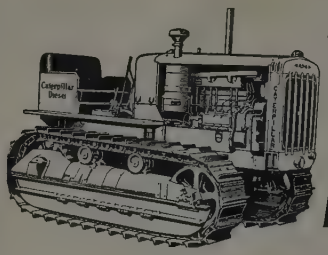

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Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to Amani.

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FOREWORD

As it happens, two of the most important contributions to this number deal with very wide entomological problems—the control of tsetse-flies and the control of mosquitoes. Either pest is sufficient not only to determine the scope and direction of organized human effort in tropical Africa, but to determine (in the original sense) the effort itself—to put an end to it. The problems are each complicated by the fact that they have to deal with more than one species, which unfortunately have their individual preferences for conditions in which to live and breed. This means that, in altering the environment so as to make it unhealthy for what may be the chief, or the sole, harmful species present, several other devils may be given the chance to enter. Hence the control of both tsetses and mosquitoes for any given place demands not only money but a good knowledge of the local climate and vegetation and also of the habits, preferences and tolerances of the pest species actually and potentially present.

Dr. Lewis gives a most valuable summary of the Kenya tsetse-fly position in relation to the utilization of the land. He shows that certain of the species present in the Colony are gaining ground and considers the possibilities of local control in the light of experience elsewhere. Finally he stresses that tsetse-control is an essential for development and that it demands concerted action.

The problem of mosquito control dealt with by Mr. Hopkins is in some respects the easier, but it demands no less knowledge and caution. As he points out, sources of the more harmless species can only too readily be changed into sources of dangerous vectors of disease. He provides a balanced discussion of the relative merits of oil and paris green as larvicides. The controlled pollution of water by means of cut green vegetation evidently holds encouraging possibilities.

Mr. Maher's article on labour on European farms is one that will certainly arouse much interest. Conditions, he says, are far from satisfactory, whether from the employers' point of view or the labourers'. An improvement in housing, feeding and amenities could not fail to benefit both parties.

The problem of using foodstuffs to the best advantage has not so far been a pressing one in East Africa, but it may become so. Dr. French's article on the rations of bacon pigs is a timely demonstration that pig-farmers can obtain as good results as at present on a reduced total protein ration, provided that this includes some animal protein. Separated milk is an excellent source.

A timely article by Dr. Nattrass deals with the worst disease known to potato growers. It is surprising that it should not have appeared, or been recognized, in Kenya before 1941. It is to be hoped that its spread into neighbouring territories, where it is not yet known, can be prevented.

OBITUARY

By the tragic death of Geoffrey Milne on the 16th of January, East Africa, and Amani in particular, has lost one of its foremost research workers. He died, after a few hours' illness, while on a visit to Nairobi, undertaken in connexion with his investigations for the East African Industrial Technical Advisory Committee.

Milne, who was born in 1898, was educated at Hymere College, Hull, and the University of

Leeds. After graduating in 1921, he was appointed Assistant in Agricultural Chemistry at the North of Scotland College of Agriculture, Aberdeen, and later, in 1923, Lecturer in Agricultural Chemistry at the University of Leeds, where he remained until 1928, the year in which he was appointed Soil Chemist to the newly opened East African Agricultural Research Station at Amani.

On taking up his new work in East Africa, Milne showed that he fully realized the magnitude of the task he had undertaken and set about it with characteristic zeal and a clear conception of what was required of a fundamental research worker. His aim when embarking on these investigations in 1929 was not to single out individual problems but to work for results of general application upon which the advisory services of the six territories might, in years to come, base their land-utilization policies. He spent eight years on the first phase of his soil reconnaissance survey before publishing the Provisional Soil Map of East Africa, in which he combined the work of all the Soil Chemists in these territories. Valuable as this reconnaissance work was, he was the first to admit its limitations and to urge that before real progress could be made the second stage, or soil survey in its proper sense, must be undertaken. Unfortunately, Milne was unable to embark on this second stage of his work because of the outbreak of war in 1939, since when he had been engaged mainly on investigations of more immediate application.

Milne was an original and fluent writer who made soil science, or pedology as he preferred to call it, a living subject. His contributions to scientific literature were not numerous, for until recently he believed that the time was not yet ripe for the publication of the mass of valuable scientific information he had gathered on East African soils. His articles in this Journal, particularly his Essays on Applied Pedology, were excellent examples of the engaging way in which Milne presented his subject. They were an earnest of what he might have written later.

Besides being an outstanding research worker, Milne was a born teacher and a gifted conversationalist. Those of us who knew him will always recall the pleasure it gave us to hear his scholarly expositions which he always enlivened with apt simile and metaphor.

A great research worker has passed from us, but he has left a wealth of carefully recorded information which, in the hands of a worthy successor, may well achieve that purpose for which Milne strove so hard during the years he gave to East Africa.

A.G.H.

A TRIBUTE TO MR. G. MILNE FROM NORTHERN RHODESIA

The death of Mr. Milne has deprived us of a scientist of the first class and of a man whose like has rarely come among us.

Many people who do good work have difficulty in not losing their way, and are also at times tempted to draw conclusions on insufficient data. Mr. Milne was at once insistent on accuracy and on pursuing the significance of details recorded. And this is one of the useful things learnt from a short though intensive association with him. But over and above a little insight into methods of work, those who met him and who had occasion to be with him for a whole gained an impression, which is indelible, of a personality rare and arresting.

The following is an extract from a letter written shortly before the journey which was to be the last he made: "The larger issues have always interested me, often when not at all my proper business. . . . I like to climb the next hill to see the whole landscape instead of dutifully tilling the soil of the valley." He said he was encouraged to this by an inscription in the room he stayed in which runs: "LEVAVI OCULOS MEOS IN MONTES UNDE VENIET AUXILIUM MIHI."

The work he has already completed testifies to no neglect of proper duty, but perhaps owes some of its excellence to this quality of being both intensive and far-reaching.

So, while grieving that Mr. Milne is not with us, we shall continue our own work with some of the inspiration which enabled him to open a window as it were onto a world that we are mostways debarred from seeing, but which, as a result of such privileged glimpses, we now know to exist. In plainer speech, it was an inspiration to meet someone who had his feet more firmly on the ground than most and who yet could have his eyes on the hills and what lay beyond.

TSETSE-FLIES AND DEVELOPMENT IN KENYA COLONY

PART I

By E. Aneurin Lewis, M.Sc., Ph.D., Entomologist, Veterinary Research Laboratory, Kabete, Kenya

The tsetse-flies and the districts infested by them in Kenya are familiar only to a small portion of the European community in the Colony. Farmers who reside, or who at one time owned farms, in areas adjoining the native reserves of Ukamba, Masai, Kamasia, and Kavirondo are no doubt painfully aware of the losses among stock brought about by these flies. Many farms allotted to settlers after the last war (1914-18) have had to be evacuated because of tsetse-flies. Other farms have, for the same reason, never been occupied. On others within range of the flies some of the farmers still struggle to maintain and to build up herds of cattle or continue to cultivate in the face of periodical decimation of their work-oxen.

The main and permanent fly-belts are in native reserves and in unalienated country where large areas are therefore uninhabitable to stock; sparsely, if at all, populated, and not utilized for the production of crops to an extent that might otherwise be possible. These tsetse-infested districts are seldom visited in normal times unless by hunters, surveyors, natives on trek or in search of water or temporary grazing in times of drought, and by those whose duty or inclination it is to consider means of improving the condition of the native peoples.

Those who have studied the development of agriculture, and the potentialities of native reserves and unoccupied land in Kenya, have realized that the existence of tsetse-flies has prohibited and still prevents extensive development. They have appreciated the need for a policy of systematic reclamation of the fly-infested zones to provide security from further fly invasions, to obtain additional space for the growing population, to increase crop-production, and to extend the areas of safe pasture land.

Among the early references to tsetse-flies in Kenya is that of Lugard's in 1893 when the fly was reported as having "only been caught as a natural history curiosity". Gregory (1896) wrote of the precautions he had to take against tsetses attacking his transport oxen. The Intelligence Division of the War Office considered the distribution of the flies worthy of study. As time went on, more and more information on these flies was collected; and as the development of the Colony progressed, greater importance was attached to their presence and to the diseases they transmitted.

In the last two decades or so, much has been written of the tsetses in Kenya, mostly in reports often inaccessible or not of much interest to the majority of the public. Governors and other administrators, politicians, militarists, travellers and hunters have remarked upon the occurrence of these pests in the Colony. Medical and veterinary officers, agriculturists, specialist advisers and visiting scientists and several commissions have recommended the adoption of a policy to reclaim the tsetse-infested areas; but a full account of the fly situation does not appear to have been available to those concerned with the problems of development in the Colony.

In the past few years, the problems of soil erosion, water conservation, overstocking, grassland improvement, increased crop production and meat supplies have been much in the mind of the public and official alike. All these are associated with intensive cultivation and increase of stock, with the lack of facilities for resting the land and with the failure to put into practice the principles of good farming as they are understood in the more advanced countries. Economic development, however, entails careful and detailed studies of a still greater variety of subjects, and requires investigations into the actual and possible repercussions of one or more specialized problems upon the others. The distribution of the different species of tsetse-flies is closely related to each of the problems enumerated and to other circumstances influencing the conditions of the agricultural people of Kenya. It is not the intention here to lay undue stress on the importance of tsetse-flies in schemes for more extensive development in Kenya, but rather to draw attention to the extent of the fly-belts, their influence on European and native agriculture, the tendency of the flies to disperse and invade new territory, the need for attacking the pest, the known methods of attack and how they can be utilized in the Colony.

Distribution of Tsetse-flies

The species that occur in the chief administrative provinces, and the proportion of infested land to the whole of each provincial area, are given in Table I.

TABLE 1

Provinces	Species of Tsetse	Proportion of infested land to whole area
Northern Frontier	*G. longipennis* ..	1 : 10
	,, *pallidipes* ..	
	,, *brevipalpis* ..	
Nyanza	,, *palpalis* ..	1 : 5
	,, *pallidipes* ..	
	,, *brevipalpis* ..	
	,, *fuscipleuris* ..	
Rift Valley ..	,, *pallidipes* ..	1 : 16
	,, *longipennis* ..	
Central	,, *pallidipes* ..	1 : 6
	,, *brevipalpis* ..	
	,, *longipennis* ..	
Coast	,, *pallidipes* ..	1 : 1·8
	,, *brevipalpis* ..	
	,, *austeni* ..	
	,, *longipennis* ..	
Turkana	,, *pallidipes* ..	1 : 4
	,, *longipennis* ..	
Masai	,, *pallidipes* ..	1 : 9
	,, *swynnertoni* ..	
	,, *brevipalpis* ..	
	,, *fuscipleuris* ..	
	,, *palpalis* ..	
	,, *longipennis* ..	

The fly-belts are not always long narrow strips of country with a uniform density of tsetse-population and in which the flies breed indiscriminately. Nor are they wide areas with a consistently even distribution of the species. They are zones of different dimensions, irregular in shape, with localities that are either fly-free or only seasonally infested. The tsetses have their permanent haunts or "homes" from which they disperse when conditions outside are favourable and to which they return in adverse seasons. As they spread from their permanent shelters, any stock in the neighbourhood move away and their owners seek safety in the hills or open country. As the flies retreat, in due course, the people follow with their animals. The natives, although not always able to identify the fly, are acquainted with these fluctuations through experience of losses from trypanosomiasis; and they suffer losses despite their acquired knowledge because they usually wait for the appearance of the disease before moving their stock.

Each species of tsetse requires different optimal conditions for reproduction and dispersal. Some are able to adapt themselves to a variety of conditions of climate created by vegetational cover. Others are more exacting in their requirements and are restricted to more characteristic environment. Yet there is a general similarity in the requisite vegetational background for the species of tsetses in Kenya.

The distribution of the seven species present in the Colony is given below, but it may be stated here that two or more of the species may occur more or less in the same locality and in the same fly-belt.

Glossina longipennis is a tsetse of the thorn-tree and dry or semi-desert areas. It is said to be independent of water, but it occurs frequently in the vicinity of dry river courses, and may be found near rivers and other watering-places. This large species certainly occurs in the bush between river valleys, and may be able to withstand drier conditions than most other species. Little is known of its habits, but recent observations by the writer indicate that the males are most active soon after sunset when they readily approach moving screen-patrols and vehicular traffic. It breeds in thorn-tree country and sometimes outside the margins of the woodland. Fallen logs and leaning trunks of trees are greatly favoured for larviposition. *G. longipennis* occupies extensive areas in the neighbourhood of the Turkwell River, the Horr Valley below Lake Rudolf, around Marsabit, Kinya Wells, Merille, and near Isiolo. It occurs in the Amaya River valley and at Baringo. It exists in the fly-belt which follows the Eastern Uaso Nyiro and appears periodically at the Lorien Swamp. The fly infests wide stretches south of the Eastern Uaso Nyiro and seems to spread over much of the country on both sides of the Tana River, which it follows to near the coast. In the Witu and Lamu districts, *G. longipennis* occurs in abundance, and it extends across the coastal hinterland from the Tana, to the Sabaki and Athi Rivers, and on to the Mombasa-Nairobi railway line as far up as Sultan Hamud. Specimens have often been recovered from trains which have passed through the coastal fly-belt. Odd flies have been collected off farms at Kiu, Ulu, near Nairobi, and as far up as Naivasha. *G. longipennis* seems to have advanced from the Kibwezi-Masongaleni belt between the Athi River and the railway to the Keiti valley area in the Machakos district, and has penetrated into the Makuyu-Fort Hall area. The species occurs in the Teita area north of Kwale and Kisigau, and may be found near the *pallidipes-brevipalpis* belt along the Tsavo and the Voi-Moshi railway line. It exists around the Ziwani swamp and at the foot of the Chyulu hills. The main belt in this direction peters out at about two or three miles north-east of the line from Chyulu to the Ithumbwa hill. An isolated patch of infestation exists on the lower end of the Southern Uaso Nyiro, and it appears to continue into Tanganyika and join with the Sonjo-Natron belt in that Territory. Ross

(1912) recorded successful transmission of a trypanosome resembling *T. cazalboui* (*vivax*) to an experimental monkey by bites of *G. longipennis*. The species was also incriminated in the outbreak of bovine trypanosomiasis on European farms in the Thika-Makuyu-Maragua district as far back as 1915, and more recently in the Ruaraka area. There is no evidence of its being a natural vector of human sleeping-sickness.

Glossina austeni is a small species of the coastal zone, where it is found in the humid atmosphere of broken forests. It does not penetrate far inland. There is a single record of its having been collected near the railway at Voi. Otherwise it is restricted to a fairly narrow irregular stretch of country from near the Tanganyika border, along the coast, to about ten miles north of Malindi. In the Sokoke forest, the fly seems to be abundant, and from previous records it may be assumed to occur commonly in Italian Somaliland. *G. austeni* is most active at night, and breeds in thickets or on the fringes of broken forest. The shelter of fallen trees and logs is a favourite breeding place. Filleul (1912) reported that this species was regarded as deadly to cattle in Jubaland. Swynnerton (1936) stated that nothing more was known of its capacity to transmit animal trypanosomiasis, and that it was unlikely to carry the human disease since it practically never attacked man.

Glossina swynnertoni, also, is somewhat localized in Kenya. It infests an area of over 600 square miles in the Narok area of the Masai Reserve, where its eastern limit is roughly the line of the Barkitabuk-Kilimafeza road, beginning about five miles west of Barkitabuk and entering Tanganyika near Loliondo. It joins on to the Musoma-Usukuma fly-belt of that Territory. The western boundary in Kenya extends from where the Mara crosses the territorial border, goes along the Mara and Isuria escarpment to near the Mara bridge over which passes the Narok-Lolgorien road. The northern line continues from Mara bridge to the Aitong hills, Lemek valley, Bardamat and back to near Barkitabuk. Since the presence of *G. swynnertoni* in the Colony was discovered (Lewis, 1932), further investigations have shown a rapid advance of this fly towards the Narok-Lolgorien road.

Apart from the valuable grazing lost on account of *G. swynnertoni* and other species of tsetse in this area, the importance of the fly is considered to be increased from the fact that it infests an area popular for big-game hunting and attractive to numerous visiting hunting expeditions. The area is, of course, uninhabited and carries no stock except occasional flocks of sheep and herds of cattle which venture over the margins of the fly-belt in times of drought.

G. swynnertoni is the savanna-woodland tsetse. Next to *G. longipennis*, it inhabits the driest and most open areas. It breeds normally in thicket, though rocks and fallen trees or logs seem to suit it equally well. In the Narok area pupæ have been collected under logs a few hundred yards from thickets and in open glades. Similar sites in the Makindu area produced pupæ of *G. longipennis*.

G. swynnertoni transmits both human and animal trypanosomiasis. Cases of the former have been contracted near the Aitong hills, whereas numerous instances of the latter have been diagnosed in sheep and cattle near Barkitabuk, in the Lemek valley and near the Mara river.

Glossina fuscipleuris is a large dark-coloured tsetse whose distribution is restricted to comparatively small localities in the west of Kenya. It has long been established with *G. pallidipes* on the lower Mara River in the Masai Reserve (Woosnam, 1914); it occurs between this river and the Mogor in the Trans-Mara and the Lolgorien areas, where it exists along with *G. palpalis*. The upper reaches of the Oyani River in South Kavirondo are heavily infested with *G. fuscipleuris, G. brevipalpis* and to a lesser degree with *G. pallidipes* and *G. palpalis*. It inhabits parts of the Gori River also. The Masai people know the fly as a voracious feeder and a vector of cattle disease, but there is no information on its ability to transmit sleeping-sickness to man.

Glossina brevipalpis occurs in a larger number of areas than the last three species, but with the exception of a single record from the northern boundary of Kenya it appears to be absent from the northern desert and from the Rift Valley and Turkana districts. At the coast the *brevipalpis* belt stretches from the Umba River near Vanga, embraces the Kwale hills and forest, passes along in a narrow strip to Kilifi, Sokoke and Lamu to near Mkauoni, north-east of Lamu. It infests the lower Tana and the wooded country in Witu. The fly inhabits the riverside forest of the Tana, but not continuously. Records have been obtained from Golbanti, Garsen, Hara, Masabubu, near Garissa, and the post of Sankuri. Also from near the junction of the Tana and Mackenzie Rivers, on the Thiba tributary of the Tana,

in the Migwani location of Ukamba, on the borders of and within the alienated farms below the Ithanga Hills, and on the Kiboko and Thika tributaries. *G. brevipalpis* was held to be partly responsible for the periodic outbreaks of trypanosomiasis among work-oxen in the Fort Hall district. One specimen was collected at a waterhole near the top of Olmundus (Emali) Hill in the Masai Reserve near Sultan Hamud. Numerous records have been made of this fly from the Tsavo River and its tributaries, and it has frequently been collected at Lake Jipe, near Taveta. It is a common pest along the Athi River and the streams which run into it from the west. The Thwaki and Keiti Rivers are heavily infested. An isolated pocket exists at Olgasalek Hill, north of Lake Magadi. As already mentioned, it inhabits the Oyani River, the Gori in South Kavirondo, and is present in abundance in remaining areas of the Kuja River. Sporadically, *G. brevipalpis* infests the shores of Lake Victoria in South and in Central Kavirondo.

This tsetse lives in dense wooding and thickets, preferably with open spaces and paths for ranging and feeding. It makes use of a variety of places for breeding, such as thickets, the bases of large trees, logs, rot-holes, fringes of thickets and even light thickets. The flies wander far and wide in the cool of the mornings, at dusk and whenever the temperature is low. Ross (1908) appears to have transmitted the human trypanosome, *T. gambiense,* by means of this species, which he then called *G. fusca,* but it does not seem to be an important natural carrier of human trypanosomiasis.

Glossina palpalis is the chief vector of human sleeping-sickness in Kenya Colony, and has received considerable attention for many years. That it also transmits trypanosomiasis to cattle has recently been confirmed by field experiments carried out by the Department of Veterinary Services.

The species has succeeded in establishing itself on that part of the Gori River on the north-west border of the Masai Reserve, and in penetrating the lower reaches of the Mogor and the upper section of the Oyani, where, however, the infestation is apparently only a seasonal one. Otherwise, *G. palpalis* is confined to the Kavirondo Reserves of the Nyanza Province. It occurs intermittently on the shores of Lake Victoria from Watende to Sio. In the Kuja river basin it thrives with *G. brevipalpis* and sometimes with *G. pallidipes* also. The riverine distribution in the Kuja catchment area and the littoral distribution cover a large area of infestation. In Central Kavirondo it has spread from the shore up the Yala and Nzoia Rivers, and has reached, by way of numerous tributaries, long distances inland. The fly exists on the rivers Safu, Waroya, Gaula, Sesi and the Huldhi near Rangalla. Outside the papyrus zone of Lake Kanyaboli the flies appear in isolated patches which no doubt join up in favourable seasons. Other infested belts occur on the Yala River as far as Abbom. The distribution of cattle is much affected by this species in the locations of Sakwa, North Ugenya, Alego, Kadimu, and Samia. *G. palpalis* is also present in rather small areas of North Kavirondo, and a few miles north-east of Busia. Its belt continues into Uganda. A small infestation exists on the Nyando, near Miwani. *G. palpalis* is seldom found far from water, and prefers evergreen forest or thicket of a heavy character. It breeds in a variety of places: in the deep shadow of clean-stemmed trees, under leaning tree-trunks or logs, under ledges of rocks and in between boulders, in light thickets with a heavy ground cover and on the margins of heavy thickets. Pupæ have also been discovered under isolated trees and in banana plantations. In seasons of dispersal and, to a lesser degree, at other times, the flies move up and down rivers, keeping close to the water-edge or taking advantage of isolated thickets or the shade of dense forest. When conditions are favourable they pass along paths and over fairly wide open spaces, and may even follow narrow open drains. Isolated spots of fly concentration have been discovered in long stretches of dense papyrus where the continuity of the papyrus is interrupted by a patch of multiple-stemmed shrubs. Several foci of this kind exist on the Gaula tributary of the Nzoia.

Glossina pallidipes is the most common and the most widely distributed of all the tsetses in Kenya Colony. Swynnerton (1936) said of this species: "No fly in East Africa exceeds *G. pallidipes* in importance in relation to animal trypanosomiasis; *G. morsitans* probably equals it." Its range is hardly surpassed even by that of *G. morsitans.* In Kenya, it is to be found in large numbers in the coastal zone from Vanga to Lamu and beyond. The Shimba hills harbour a varying density, and the belt extends, with interruptions, to the Kisigau hills, joining with that of the Tsavo River area. The species is common from Lake Jipe and the Ziwani swamp, along the Tsavo, to Voi. It infests the Rombo and Kikalelwa streams, and the area up to the Chyulu Hills.

KENYA COLONY

DISTRIBUTION OF KNOWN TSETSE-FLY BELTS

Scale of Miles

Miles 20 0 20 40 60 80 100 120 Miles

Belts of tsetses affecting man and animals

" " " " animals only

European Highlands

SPECIES-COMPOSITION OF FLY-AREAS:-

1. Glossina swynnertoni
2. " pallidipes
3. " fuscipleuris
4. " brevipalpis
5. " palpalis
6. " longipennis
7. " austeni

? Tsetses reported: Species and distribution not known.

E. A. L. NOV. 1941.

It follows the Tsavo to its junction with the Athi and spreads over the watershed of the Voi, the Athi and the Tiva Rivers, the western tributaries of the Athi being particularly favourable. All along the railway to Sultan Hamud, *G. pallidipes* is the prevalent tsetse. It covers a good deal of country from Kibwezi to the Keiti Valley. A small area of infestation exists on the Southern Uaso Nyiro to the west of Lake Magadi; and the flies tend to spread further north, and up some of the tributaries flowing from the Narok area of the Masai Reserve. The Osero fly-belt with *G. swynnertoni* also contains a lighter infestation of *G. pallidipes* which, however, has advanced north of the Narok-Lolgorien road to Engerendi Hill and possibly further. It is not without interest to note that it was into this area of over 900 square miles that the pastoral Masai were moved in 1911 from the Laikipia district.

In the trans-Mara area of the Masai Reserve *G. pallidipes* inhabits sections of the Mogor and several of its tributaries as far as the Engituak stream near Kilgorris on the Masai-Kavirondo boundary. It has already been mentioned that this species of tsetse occurs with others on the rivers Gori, Oyani, Kuja and many other of the tributaries of the Kuja in South Kavirondo, as well as around the shores of Lake Victoria, at least as far as Homa Point. In the Lambwe Valley, which opens into the Kavirondo Gulf a little east of Rusinga Island, field experiments on the control of *G. pallidipes* have been carried out, by grants from the Colonial Development Fund and the Local Native Councils, in much the same way as the recent experiments against *G. palpalis* in the Kuja River area and in Central Kavirondo.

In Central Kavirondo, *G. pallidipes* is present in the neighbourhood of Port Victoria, in Kadimu, and around the Nzalagobe Hills as far as Sio. It penetrates inland, and follows the river valleys to a smaller distance than *G. palpalis*. There is evidence, however, of its slow progress in invading Samia and Ugenya locations, where cattle once thrived, but cannot now be kept for long because of trypanosomiasis.

G. pallidipes is the prevalent species on the Wei-Wei River in Turkana, the Malmati, the Kerio, the Seya and the Amaya Rivers, from each of which it disperses widely in and after the rains. It occurs in the narrow fringing forest of the Eastern Uaso Nyiro and concentrates near pools and waterholes in the vicinity. The foot of the Mathews Range is infested, as are the Uarguess Hills, the neighbourhood of the "promised land". This, too, is the species that disperses widely and affects the border farms allotted under the Soldier Settlement Scheme after the last war (1914-18)—the farms of lower Subukia and Solai, those of Ol Arabel Valley, and others in the vicinity of the Ithanga Hills and the Yatta. Other border farms open to European occupation but threatened by this tsetse are those in the Emali-Sultan Hamud area, and at the coast.

G. pallidipes breeds in thickets, at the bases of trees, and even under logs and fallen branches in moderately open country. Experience in Kenya indicates the fly's preference for light extensive thickets under the shelter of trees with a loose canopy, thus permitting the penetration of dappled sunshine. In such thickets the pupæ are widely distributed under a carpet of humus or ground plants such as *Sansevieria*. The pupæ are often numerous and not difficult to find. In the case of dense, semi-evergreen thickets they are confined to a narrow peripheral band or in sites somewhat exposed to sunlight owing to the thinness of the canopy. More rarely the fly deposits its larvæ in rot-holes of trees and what may be termed "nests" of pupæ and puparia are sometimes found under clean-boled trees or in rich humus covered by decaying branches of *Euphorbia candalabra*. This fly requires more and heavier thickets than *G. swynnertoni*.

G. pallidipes ranges and hunts for food through tree savannas adjoining riverine or other suitable thickets. It follows the margins of its breeding-places, travels along roads, paths and game tracks, and seems to be especially attracted to open glades in large masses of broken thicket. It frequents smaller glades which are connected by natural or artificial grassy lanes or tracks, and follows the scent of animals for long distances. The species adapts itself to diverse types of vegetation. Some localities, however, are so lightly infested that the presence of the fly is detected only after prolonged and repeated search. Nevertheless, the small numbers manage to feed frequently on any cattle within range, and may thus cause serious losses from trypanosomiasis. This fly is not a natural carrier of sleeping-sickness to man.

Glossina morsitans has not authentically been recorded from Kenya Colony. Specimens referred to as *G. morsitans* by early pioneers were probably *G. pallidipes*. Recently, however, Mr. G. H. E. Jackson, of Uganda, has drawn the author's attention to the occurrence

of *G. morsitans* in the most north-eastern districts of Uganda. This eighth species may have crossed to the border and may be responsible for the infestation in the hilly district north-west of Lodwar in Turkana.

It has been estimated that over one-seventh of the whole of Kenya has largely been appropriated by tsetse-flies. Most of this area is uninhabitable for the greater part of the year, and life for domestic stock is always precarious.

Tsetse-flies and Soil Erosion

It is not an exaggeration to state, as did A. G. Church (1927) in his *East Africa: A New Dominion* that, "in every British territory in East Africa the fly areas are increasing, and the area of desolation is spreading with disastrous effects upon their economic development." Despite the fact that a complete fly survey has never been undertaken systematically in Kenya, and it may be stated therefore that there is no criterion on which to base an estimation of fly-encroachment, there is evidence of advance in several localities; and these new invasions are slowly but surely forcing the people into more and more congested areas.

A vivid picture of the mechanism of fly-advance and its effect is given in one of a series of articles issued in 1934 by members of the Tsetse Research Department, Tanganyika: "Where the advance comes in contact with settlements, cattle begin to die, and the outer ring of native landholders moves away. The bush regenerates in their wake, if indeed it be absent; the tsetses come on, and the next ring of the settlement retires. In this way the natives are driven into more and more congested areas circumscribed by fly, which closes in upon them until, unable to contract further, they remain in a congested condition. The cattle which survive overgraze the congested area still fly-free, which soon becomes a sandy and eroded waste on which emaciated animals eke out unprofitable lives and die in large numbers annually from starvation as well as fly. The removal of vegetation in the overcrowded settlement destroys the water conservation, and water shortage is added to semi-starvation of the stock."

The invasion of new territory is not spectacular, nor do the people readily abandon the land on the first encroachment by the fly. They cling stubbornly (courageously?) and hopefully to their homes until from heavy losses and sheer necessity they are compelled to retreat to areas already inhabited to full, or nearly full, capacity.

More useful land, even in alienated parts of the Colony, is being surrendered when the need of the people is already sufficiently pressing.

It is true that the tsetses have not driven out the whole of the population from every infested district, and that the people living in isolated villages within the permanent fly-zone, or on the fringes, continue to cultivate the land or to pursue other means of livelihood. There are, however, vast areas devoid of agricultural life and in which tsetse-flies have contributed to the desolation. It was with reference to such areas, presumably, that Kirkpatrick (1937) remarked, "Animal trypanosomiasis has been by no means an unmixed curse. Soil erosion, even though it has only recently become 'news', has been, is, and will continue to be, one of the greatest problems of tropical Africa. Nothing that has so far been done to combat the menace of soil erosion has been so effective as the work of the tsetse-flies." He amplifies these remarks and explains that in the fly-belts man lives in scattered villages, cultivates, but cannot keep cattle. There is an abundance of game which he can hunt (!). Abolish the tsetse and the area open to destruction is increased. Kirkpatrick goes on to ask, "Shall we then acclaim the tsetse as a guardian of the country—for this it undoubtedly has been . . .?" With an answer in the negative, he proceeds to recommend driving out the tsetses, planning settlement, preserving indigenous trees, improving the quality of cattle and regulating the density of population. He advises the prevention of soil erosion by the rotation of crops, the use of manures, and the introduction of a variety of food and cash crops.

An idea somewhat similar to that expressed by Kirkpatrick on the influence of the tsetses on soil erosion and soil conservation appears in *The Rape of the Earth: A World Survey of Soil Erosion* (Jacks and Whyte, 1939). The authors state, "Again, the tsetse is delaying the spread of the people from certain overpopulated areas. At the same time the presence of the tsetse in many parts may be a blessing in disguise, as it can be regarded as a trustee of the land for future generations."

The urgent need of preventing soil erosion must be appreciated by all, and Kirkpatrick's recommendations as quoted meet with general approval; but this view of a widespread, injurious pest in the guise of a protector of the country which it infests is, to say the least, strange. It depicts the surrender of a trusteeship to an agency which offers no assurance

of release of the fly area, nor any security to the neighbourhood; it hinders development, and is continually threatening to take possession of additional land; it represents the exchange of one evil for another, both destructive. The view is unfortunate in that it tends to support an attitude of complacency already disconcerting to organized control of tsetse-flies, a control that takes full consideration of the maintenance of soil fertility and economic agricultural development.

Tsetse-fly infestation is one of the fundamental contributory causes of soil erosion as described in the article from the Tsetse Research Department, Tanganyika; but it is by no means the only factor in the problem of soil erosion in Africa. Many eroded areas are situated far from tsetse country. Land within some of the fly-belts shows unmistakable evidence of erosion due to other causes. There are, for instance, areas of semi-desert scrub with extensions of eroded waste stretching into tsetse-infested parts of Kenya Colony.

Tsetse-flies and Cultivation

The effect of fly-infestation on cultivation in native reserves is of no small importance. On the other hand, judicious cultivation can be utilized, with advantage, to the control of tsetses; and to the benefit of the health and standard of living of the native people.

In Kenya, the most common and important species of fly inhabit the valleys where conditions favour a luxurious growth of vegetation and are conducive to profitable cultivation. The soil is rich in plant food, and with reasonable precautions can easily be protected from erosion. The cultivated land may readily be converted into good pasture if the soil is not seriously impoverished by continuous cropping without manuring.

The natives are, however, generally reluctant to grow crops in the floors of these fertile valleys mainly because they cannot safely keep their cattle within easy distance of villages situated in or near the fly area. They naturally desire to have their stock at hand and to obtain nourishment from the milk and meat. Their efforts at cultivation, even in fly-free areas, seldom conform to the requisite standard of cultivation; much less can they be expected to exert themselves in the face of a relentless pest. The permanent tsetse infestation may be confined to a very narrow strip of riverine bush, but in favourable weather the flies may spread over a much wider area and force the inhabitants to live on, and cultivate, the poorer land and more erodable soil of the watersheds. It would seem practicable to initiate a system of cultivation in the rich riverine belts that would speedily be remunerative from the crop and the cash point of view; that would relieve congestion on the impoverished soil on the steeper gradients, permit a period of rest for recovery, and encourage the progress of improved agriculture under conditions more attractive to the native. At the same time, the breaking-up of thickets and the preparation of cleared ground for the crops would serve to destroy the habitat of the fly and reduce its ability to spread. Stock could be admitted as the cultivation proceeds into the fly-infested bush, the clearings providing effective protection from the tsetses. Timber, fuel and shelter trees could be planted as the tsetses are pushed back or exterminated.

A scheme to stimulate the production of crops and to utilize the fly-infested bush at the coast was considered by officers of the Department of Agriculture. It was thought that an area within the fly-belt could be cleared of the bush, cultivated, and in due course sufficiently protected to allow the introduction of a small number of cattle to the enclosed settlement. The scheme was in most respects similar to that which has been in operation for many years in Tanganyika. The concentration of settlements within a fly-belt, planned and supervised by the Medical Department of that territory, has been a great success in reducing the incidence of human sleeping-sickness, but there is evidence that up to recently little had been done to foster development or to improve the methods of farming. Lester (1939) reported that in Tanganyika the officers in collaboration with the natives choose an area where the soil is suitable for cultivation, the water supplies are adequate, and the system of roads is satisfactory. At first, the allowance of arable land was made small enough to ensure rapid clearing of bush, in order to make the settlements fly-free, but this caused congestion, discontent, and soil exhaustion. The present policy is to allow about eight acres of land for each family with about eight acres for additional expansion, and more land is made available when required. The settlements contain at least 1,000 families. It has not yet been possible to keep cattle in these areas, but the natives are allowed to kill game. Lester drew attention to the need for co-operation between the administrative, medical, veterinary and agricultural officers in improving the methods of agriculture in these settlements, and refers to the value of demonstration farms.

(*To be continued*)

COMBATING SOIL EROSION IN THE CENTRAL PROVINCE OF TANGANYIKA TERRITORY

PART II

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Soil Conservation Measures Suitable for Central Province Conditions

A description can now be given of the soil conservation measures which from investigation and experience over the past ten years seem to be the most suitable for Central Province conditions. While particularly badly eroded areas may require special treatment, the basis of any anti-erosion programme should in my opinion be "good farming". In other words, agricultural practices should conform with the needs of the land or the dictates of Nature. It is for this reason that I think that an improved standard of living for the native population in the Central Province lies with the development of animal husbandry rather than crop production; for grass is the most reliable crop which can be produced there and protection of the soil and the maintenance of its fertility seems infinitely easier in the pasture land than it does in the arable land.

Deferred Grazing Systems

As it is now clear that deferred grazing is not only a valuable soil conservation measure but also is essential in all pasture improvement programmes under semi-arid conditions, it is placed first in importance. In the pasture work at Mpwapwa and the various grazing schemes in the Province already referred to, these effects of deferred grazing have invariably been most impressive.

Any grazing system to be suitable to the primitive conditions we have to deal with here must be extremely simple. The two systems advocated are in fact the simplest possible to devise and may be termed: (i) the seasonal deferred grazing system; and (ii) the "chess-board" deferred grazing system.

Seasonal Deferred Grazing System.—This system is only suitable to conditions where ample unused or relatively unused pasture is within reasonable reach of the areas it is desired to improve. The idea is to make use of this unused grazing during the rains when the provision of adequate water supplies for the stock usually offers no great difficulties. With a yearly rest period of four or five months during the growing season, revegetation of denuded pastures in the Central Province is rapid, while the extension of the grazing grounds further increases the feed available for the stock and thus reduces, at any rate temporarily, the intensity of the grazing.

If the rest period commences about two months after the start of the rains (about early February) it appears to be quite sufficient. In the Mpwapwa experiments grazing during the first part of the grazing season appeared actually to encourage the more valuable perennial grasses by controlling to some extent the free growth of the annual species [6]. Good results have been obtained even where the small stock of cows in milk with their calves are allowed to remain on the home pastures. Here too the Mpwapwa experiments indicate that light grazing with cattle during the rains does not damage pasture, and browsing with goats actually appears to improve the grass cover by controlling to some extent the bush growth.

The native stock-owners, many of whom are well accustomed to the seasonal movement of their stock owing to shortage of grazing or of water, readily appreciate the benefits of this grazing system in providing feed for their stock during the dry season. They do not, of course, value it as an anti-erosion measure. Where the wet season pastures are reasonably nearby and the people have been allowed to retain their small stock and milking cows, the chiefs and the majority of owners have been enthusiastic in their support.

The "Chess-board" Deferred Grazing System.—More usually, however, no easily developed new grazing grounds are within ready reach of overstocked areas. Here I advocate the introduction of the "chess-board" system of deferred grazing. In this system it is necessary to divide the land into convenient-sized blocks, say one mile wide by two miles long. These blocks must then be sub-divided into two halves. Any simple but preferably permanent system of demarcation will do. Earth mounds one hundred to two hundred yards apart and planted with candelabra *Euphorbia*, manyara (*Euphorbia tirucalli*) or sisal have proved satisfactory. Common sense should be used in deciding where the dividing lines should go and it would seem that each headman's area should be treated as a separate unit.

The grazing system then merely entails that the "white" blocks should be reserved one year and the "blacks" the next. Thus half of the grazing land will be rested every year and will have the opportunity of seeding and free growth for a part of the growing season. The recovery of denuded pastures will not be as rapid as where the seasonal deferred grazing system is enforced, but wherever this system has been applied in the Province the general improvement in the grass cover, particularly of perennials, has been marked even after the first year.

It is recommended that the rest period should commence at the begining of February and finish with the harvesting of crops. This allows the whole of the grazing to be available for the first two months of the rains when food is scarcest. As mentioned previously, resting during the whole of the rains also tends to favour the annual species at the expense of the more valuable perennial grasses [6].

A question frequently asked is: Will not an increase in stock numbers, which may be anticipated, nullify the good effects of these deferred grazing systems? The reply to this is that at Mpwapwa it has been found extremely difficult to damage a Star-grass pasture by overgrazing, if it is rested during a part of the growing season. Secondly, the native stockowner seems at last to be learning to sell his stock more freely as the result of economic pressure, propaganda and the development of markets. This question, however, is important and requires constant consideration, but I emphatically do not think that it should in any way interfere with the introduction of deferred grazing into native practice.

Ridge Cultivation

For many years a certain amount of ridge (*tuta*) cultivation has been carried out in the Central Province, chiefly by Wanyamwezi settlers, who it should be mentioned have often been wage earners and not entirely dependent upon their crops for their subsistence. The local tribes do not normally practice this method of cultivation, except for the sweet potato crop, which is planted in February or March at the commencement of the "big" rains.

The Mpwapwa erosion plots have shown [3] that contour ridge cultivation, if the ridges are sufficiently large and well constructed, afford perfect protection to land under crops even with the heaviest storms. Experiments at Agricultural Stations in the semi-arid areas of Tanganyika has also shown that higher yields can be expected from ridged fields than with flat cultivation; it is only in this way that fairly uniform distribution of the moisture can be made available for the plants and thus enable maximum yields to be obtained in a dry climate. Experience in endeavouring to introduce this method of cultivation into native practice in the Province, however, has proved that it is beset with difficulties for various reasons which I will endeavour to explain:

(*a*) With a short growing season early planting of grain crops is most essential. The normal practice at present is to do most of the planting after the first rains have fallen and without preparation of the land, apart from the gathering and burning of the previous season's stubble.

(*b*) The first cultivation is done when the first weeding is necessary; hence it is a combined operation. With some tribes this first cultivation is fairly deep, with others it is very shallow and entails comparatively little work. Hence ridging the land, either before the rains commence or immediately afterwards, means extra work, and before a man has finished riding his land he finds that the first made ridges need weeding; the result tends to be neglect of weeding, and reduced yields.

(*c*) It may appear that the solution to these two difficulties is to dry-plant on ridges made the previous year. This was tried on a number of fields in the Dodoma Reclamation Area this year, but with indifferent success; the ridges tend to shed rainfall and the seedlings therefore suffer badly from drought during dry spells. Possibly making wide ridges (say 5 ft. apart) and planting on the sides thereof will be more successful, but this method has still to be tried out.

(*d*) Preparation of the ground before the rains has been suggested. While with certain soils this is possible, most soils are too hard to cultivate properly in the dry season, particularly with the hoe in general use in this Province; in the Msamalo Reclamation Scheme where this was tried, the people complained of their hoes breaking and being worn down too quickly.

(*e*) Lastly, while well-made contour ridges can be completely effective in preventing erosion, those made by the average native cultivator in the Central Province are by no means so effective. In fact numerous instances have been seen where the effect has been to increase the erosion rate by concentrating the run-off!

For these reasons I now incline to the view that ridge cultivation under Central Province

FIG. 1

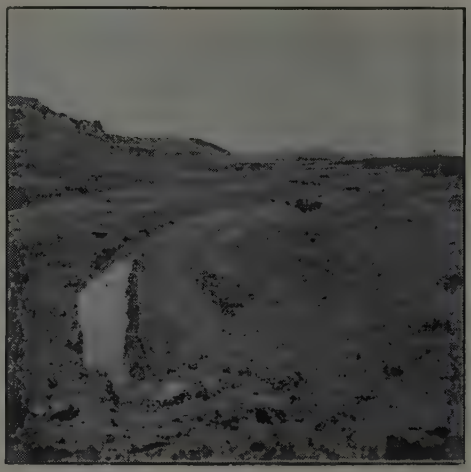

FIG. 2

FIG. 3

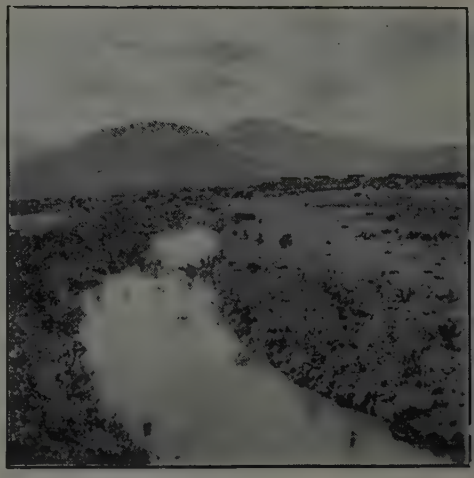

FIG. 4

CONTOUR BANKING IN BASUTOLAND

Figs. 1 and 2, the banks are being made and planted with grass.
Figs. 3 and 4, two years later, and after a heavy shower of rain.

conditions requires further study before schemes to enforce it on any large scale should be considered. In the meantime its application to closely supervised specified areas will give valuable information and demonstrate its efficiency in increasing crop yields.

Contour Banks

A great deal of attention in recent years has been given to the construction of contour banks as an anti-erosion measure. A well-managed pasture, even in this arid Province, does not need this special protection from erosion, nor does arable land properly ridge-cultivated by hand. But this high standard of farming will be long and difficult to develop under primitive conditions; and there is no doubt about the efficacy of contour banks in speeding up reclamation of eroded areas and in conjunction with other measures assisting in the protection of the land. For these reasons I think that contour banks should play an important part in a soil conservation programme for this region.

A large variety of types of banks have been under trial and use. The main differences are: graded or level, broad-based or narrow-based, with or without interruptions (openings) and with or without a furrow on the top side. They may be designed to hold up all or a part of the run-off and generally have been most successfully used in undulating country of medium or low rainfall. Choice of type of bank to construct rests largely on the labour and implements available. If designed to hold only a portion of the run-off, particular attention should be paid to the drainage channels discharging the run-off from the contour banked area.

The striding level as designed by Wade and Cawley [7] and modified by Savile [8] has in my opinion provided the ideal instrument for use by natives in the lay-out of contour banks and seems to me to have put an entirely different complexion on this type of anti-erosion work in native areas. Any African of average intelligence can learn to use it with very little instruction and then can lay out a surprisingly accurate contour line either level or with any grade required. Its use makes it impossible for the operator to take short cuts across the irregularities of the ground, as is liable to happen when natives use most other types of levels. It is cheap and is easily made by any carpenter: at Dodoma the cost is Sh. 20 each.

Type of Bank.—The type of contour bank that has proved most successful under Central Province conditions is one which holds (or allows to drain away slowly) the maximum amount of water in comparison with the work of construction. For this reason a bank made with the soil taken mainly from a furrow on the top side has been adopted.

Size of Bank.—This will vary greatly according to soil type and plant cover. In the Mpwapwa run-off plots [3], for example, a heavy storm will give a run-off from bare, baked ground (a red loam) of about 75 per cent; a plot planted to maize, as high as 50 per cent; while a plot with a good grass cover, less than 10 per cent.

Banks of various widths and heights have been tested and I now favour a bank six to eight feet wide at the base and eighteen inches high (from the bottom of the furrow). If the banks are made with a flat top four to five feet wide, they grass up well and also a better job can be made of the work by unskilled labour.

Grading.—Many of the eroded areas of the Province are so cut up by gullies that graded banks are difficult to construct. Taking the banks across deep gullies is expensive in labour and they must at these points be carefully constructed (any loose sand taken out and the soil well consolidated by stamping during construction). If the land is so broken as to restrict the length of the banks to less than 300 yards, then level banks made correspondingly larger and more closely spaced seem best. If the length of the banks is more than 300 yards I think they should be graded with a fall of 1 in 500. No banks should be more than about half a mile in length. Frequently the central section of about two hundred yards should be level and the grade should fall in both directions.

Espacement. — This is perhaps the most difficult point to decide and I think requires further investigation. At present I favour 15 to 25 yards apart according to the steepness of the slope for level banks and 20 to 40 yards apart for graded banks. Type of soil and vegetation cover greatly affect the run-off rate and it will probably be found that under certain conditions these distances can be increased.

Outlets.—In Basutoland, where a great deal of experience has been obtained with contour banking, very careful attention is paid to the grassing of the drainage channels taking the discharge from the graded banks. The work there, however, is under direct expert European supervision. In this Province, with African staff only, this is not possible, but I

recommend that where available, sisal should be planted to protect the furrow outlet from each graded bank.

Protecting Drains.—A more steeply graded drain to protect a contour banked area from the run-off from above (e.g. the slopes of a stony hillside) is essential. It should be constructed to a size and grade sufficient to take the heaviest storm which may be experienced over a period of years. On long slopes I think secondary protecting drains below the main drain should be made at intervals of about a quarter of a mile.

Check-dams in Gullies.—These are not recommended except under exceptional circumstances, as with very erodible soils a new channel is quickly formed. With the use of hand labour alone they are also expensive to construct.

Labour of Construction.—The red and grey earths of good depth and free from stone are friable and readily broken up by a pickaxe during the dry season—the time of year most convenient to carry out this work. Under the best soil conditions, a reasonable task for average labour (each man equipped with a pick and shovel) is 150 cub. ft. of soil. This means digging a furrow of say 30 ft. long by 5 ft. wide and 1 ft. deep, the loosened soil to be made into a bank of the required size on the lower side of the furrow. The steeper the slope naturally the more soil is required to build a bank of the required size; hence tasks will vary from ten to fifteen yards of banking under the best conditions and somewhat less in stony or gravelly ground or on steeper slopes.

Maintenance.—This is, of course, a matter of the greatest importance and requires further thought and study. I strongly favour no crops being permitted to be planted on the banks and planting them with protective perennial grasses such as Star grass. In crop land, Native Authority rules to enforce all or part of the uneaten crop residues being stacked on the banks instead of being burned, should be considered. Protecting drains can best be maintained by planting with sisal or if this is not available with manyara (*Euphorbia tirucalli*). As a general principle I think, too, that contour banking should be confined to densely populated areas, where the land is more or less under continuous cropping or in a comparatively short rotation under a grass/weed ley.

Bush Clearing

My views, based largely on work carried out at Mpwapwa, on the value of bush clearing in regard to the use of the land, are expressed in an article [9] published recently in *The East African Agricultural Journal.* In addition to many other advantages (tsetse control, pasture improvement, etc.) to be obtained by controlling bush growth in these dry areas there is little doubt that it assists greatly in reducing run-off and soil losses in grazing land. To obtain the maximum benefits from this operation, however, the enforcement of a system of deferred grazing is essential.

In the cooler and rather better rainfall areas of the higher lying portions of the Province (Singida, Mkalama, Manyoni and Irangi) grasses are not so readily suppressed by bush growth. In these areas, too, bush regeneration is often largely or completely controlled by a combination of goat browsing and the normal cultivation and fuel and timber requirements of a dense and settled population. Where possible, therefore, the most sensible method of keeping down undesirable woody vegetation is by controlling settlement and thus avoiding small settlements dotted about on their own in a sea of bush. In Ugogo, with its lower population-carrying capacity and generally poorer conditions for grasses, the problem is more difficult and requires, I think, further study. It does seem, however, that small "cultivation steppe" islands are slowly developing and with encouragement we may find that much may be done. As a start I would favour concentrating on suitable demonstration areas, e.g. around Dodoma township and possibly the Mvumi-Handali area, which in a large measure is already open land.

We must realize, too, that except in flood-plains the natural vegetation of this Province is woodland (thicket or scrub) and the maintenance of grassland will always entail labour spent on weeding. From the experience we have obtained at Mpwapwa it takes yearly from two to three men-days per acre to control the woody regeneration in a pasture.

Grass Planting

The majority of the grasses in the Province are annual species. This applies particularly to secondary thicket or over-grazed areas. Perennial species, which naturally tend to afford much better protection to the soil, can be encouraged in two ways: (i) by suitable management; and (ii) by planting suitable species. The latter has given excellent results at Mpwapwa and on the three Demonstration Stock Farms already mentioned as being maintained at Dodoma, Kondoa and Singida by the Veterinary Department.

The grasses which have given the best results are the larger types of the local *Cynodon* (Star grass). African Foxtail grass (*Cenchrus ciliaris*), another indigenous species, has also given useful results in some instances. Star grass in this dry Province can only be successfully established by planting roots and great care must be taken to plant these out during wet spells of weather. The African Foxtail grass is readily grown from seed.

Manuring

Manuring of land is mentioned here as this practice, apart from increasing crop yields, by adding organic matter to the soil and thereby improving its structure, increases its power of absorbing the rainfall and thus reduces both run-off and erosion. The use of manure is gradually, and in places rapidly, becoming more popular, particularly in badly eroded land through dire necessity; but anything that can be done to encourage this practice will be useful.

Hedging and Planting Windbreaks

The protective effect of a dense hedge in preventing soil wash is well known. Hedges have been most used in parts of the Singida district, where the cuttings or poles of the local *Commiphora spp. or manyara* (*Euphorbia*) are fairly widely planted to protect fields from stock or game. Chief Salim of Irangi has made use of sisal for a similar purpose, with marked success.

Hedges of cut thorn are used also in different parts of the Province and serve a useful purpose not only in protecting crops but in controlling the regeneration of bush. Native Authority Rules to make their use compulsory in certain areas is worth consideration.

Tall hedges, particularly of *manyara,* also afford a large measure of protection from wind erosion. In parts of Singida district, where winds are unusually strong, this protection is especially necessary, particularly to cultivated land. Well grassed pasture land in this Province does not seem to suffer seriously from this form of erosion.

Burning of Stubble

It is customary throughout the Province to clean all land to be planted that year, before the commencement of the rains. Thus the remaining stubble of the previous season's crop is destroyed by burning and the soil thereby deprived of organic matter. A more sensible procedure would appear to be to lay this trash on contour lines to assist in preventing soil wash. If laid on contour banks, where these have been made, it will assist greatly in their maintenance. It is realized that the burning of the trash may have sanitary value in reducing insect pests and plant diseases, but this possible advantage seems greatly outweighed by the disadvantages. The enforcement of Native Authority Rules to this effect, wherever they have been made in this Province, has not been found difficult.

A Soil Conservation Programme

I have endeavoured to outline the position in the Central Province in regard to soil erosion and what progress has been achieved in its solution. Soil conservation measures considered suitable for incorporation in the primitive system of land-use in this Province are also described. It is my hope to see more rapid progress made in their application, either individually or in combination according to local needs and as circumstances permit. Each locality will to some extent require measures suited to its own peculiar conditions and a single measure by itself may be ineffective. In other words, combined planning is essential. The necessity for staff (particularly trained Africans) and continuity in the work need hardly be emphasized. It is equally important for all concerned to become soil conscious. How can all these requirements be met?

The best solution under present conditions (that is in the absence of a Soil Conservation Section for the Territory) seems to me to have a standing provincial committee to control all soil conservation projects in the Province. The members of such a committee would naturally be the representatives of the departments concerned and would have as their chairman the Provincial Commissioner. It may well be a sub-committee of the proposed Provincial Welfare Committee, and it could perhaps deal with all matters connected with land use in the Province. Exploitation of soil fertility in this Province has gone far and in many areas too far. Now that stock has been taken of the subject as a whole, all who can should add their quota to the tremendous though not impossible task of remedying matters.

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POTATO BLIGHT

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The Late or Irish Blight is the most destructive disease to which the potato is subject, and occurs in most parts of the world where this crop is grown. Given a certain set of weather conditions the disease can sweep through a crop and across the countryside with amazing rapidity, leaving destruction in its wake. It attacks wild species of the potato in South America, the native home of the potato, where the disease is endemic. Early records show that the disease was prevalent in France and Germany as early as 1840, but it may possibly have been a factor in the cultivation of the potato since its introduction from South America in the sixteenth century.

In 1845, when conditions must have been exceptionally favourable, the Blight reached the front rank of importance in Western Europe and at the same time in the United States. In this year occurred the historic outbreak in Ireland, resulting in the almost complete failure of the potato crop, on which the population then largely subsisted. The consequent famine profoundly affected the course of Irish history[1] and indeed that of both Britain and America. Since then the disease has spread round the world. India was not invaded until between 1870 and 1880, and Australia until 1909, in which year severe outbreaks also occurred in South Africa. As far as is known the disease was not recognized in East Africa before 1941. This must be regarded as an event of some significance, and may possibly affect the future cultivation of the potato in these territories.

Late Blight, so called because in Europe it usually attacks plants late in the growing season, may be recognized in the early stages by the appearance on the leaves of dead areas of varying size and shape. The main characteristic is that they do not have a very sharply defined margin such as that which distinguishes the Early Blight (*Alternaria solani*), but, when fresh, appear to merge gradually into the healthy tissue of the leaf, and can best be described as blotches rather than spots. The lesions occur usually at the tip or on the sides of the leaf, growing in from the margin. More rarely the lesion is situated away from the margin and expands radially. The leaf stalk and the main stem are also attacked, in which case the leaves often hang down in a manner somewhat resembling Leaf Drop Streak Disease. The first indication is a water-soaked area which eventually turns brown, and, as it increases in size, always has a water-soaked margin which can be seen on holding the leaf up to the light. The actual appearance of the affected foliage depends a good deal on the weather at the time. If wet, the lesions may appear almost black or dark brown, by which colour they are generally described. When the foliage is drier, the centre of the diseased tissue may be a very light brown merging into a dull olive or brownish green with a light green margin. During showery weather or in the morning when humidity is high, a delicate white mould can be seen on the underside of the lesion, especially round the margin of the diseased area. If moist weather continues after infection the disease soon involves the whole plant, which rapidly decays, giving off a characteristic odour. In less intensive attacks the leaves may all dry off, leaving the stems erect and still green.

Few diseases are more dependent on weather conditions than Blight. If the disease is present an epidemic attack may be expected when the temperature is above 50° F. and humidity is maintained at 75 per cent or over for three days or more. These conditions are provided by consecutive rainy days or dull cloudy weather with intermittent showers. In some countries farmers are warned by a special meteorological service when these conditions are to be expected.

If the weather continues wet after the leaves have been attacked the tubers may also become infected. This is brought about by the fungus from the leaves being washed down through the soil on to the tubers below. In the earliest stages of attack there is a slight brownish discoloration of the skin. The flesh below is slightly shrunken and usually of a rusty brown colour. The tuber rot is essentially a dry rot, and does not as a rule pass from a blighted to a healthy tuber by contact. In wet soil, however, and when storage conditions are unfavourable, this dry rot is quickly followed by a wet rot, caused by other organisms, which may involve a large proportion or whole of the bulk.

After the catastrophic outbreaks in 1845, the disease was studied with vigour, both in Europe

[1] For an account of the 1845 epidemic in Ireland see *Famine* by Liam O'Flaherty; Gallencamp, London.

and in the United States. It was attributed to a parasitic fungus by both Von Martius and Berkeley in that year, and in the same year was described and named *Botrytis infestans* by Montagne. The present name, *Phytophthora infestans*, was given to it by De Bary in 1876.

The fungus, entering and ramifying within the plant tissues, eventually, when conditions are sufficiently moist, grows out through the under surface, where it becomes faintly visible as a white mould or mildew which is characteristic of the disease. The mould which occurs at the margin of the diseased tissues, where the fungus is actively growing, is the fruiting part of the fungus, and consists of branched upright hyphæ (conidiophores) bearing a number of pear-shaped spores. Each of these bodies, which may be blown about by the wind, can infect other leaves, providing a film of moisture is present, by liberating a number of smaller motile spores (zoospores), which can swim independently in a drop or film of moisture on the plant. After a while they settle down, push out a tube which enters the plant through a breathing pore, and then forms a system of ramifying threads which totally destroy the leaf tissue. The fungus, as it progresses, is always slightly in advance of the area bearing the mould, and its effect can be seen as a water-soaked zone. With a limited moisture supply motile spores may not be produced, but the pear-shaped spore itself may germinate and infect a leaf direct. In dry weather the spores quickly die and none is produced from dried-up foliage.

Not only do the enormous numbers of spores produced serve to spread the disease from plant to plant and by wind from field to field, but, as has already been stated, infect a certain number of tubers below ground. Tubers may also become infected at the time of digging if they come into contact with diseased foliage. It is the slightly infected tubers which serve to carry the disease on from season to season. These, if not too badly diseased, produce shoots already infected with the fungus, which eventually appears as the spore-bearing mould on the young shoot. It is from such plants that an outbreak of the disease is started each season. As far as is known, there is no other stage in which the fungus can over-winter. Resting spores occur very rarely in nature, and there is no evidence that the fungus can live saprophytically in the soil or on plant debris.

The necessity for the fungus to over-winter does not of course arise in Kenya. It is merely a question of tiding over from one crop to another. With the climate experienced in this Colony, potato plants in one stage of growth or another are almost invariably present in all localities where squatter shambas exist or as volunteer plants among other crops. It is not impossible that in sheltered positions where humidity is maintained at a fairly high level that the disease will persist from season to season. It is perhaps idle to speculate whether the disease is a new introduction or has been present unnoticed until the exceptionally favourable weather of 1941 enabled it to assume epidemic proportions. At any rate, there are no records of the disease having been seen before either in Kenya or other East African territories, although the crop has been grown here for many years.

Control Measures

In countries where the disease occurs regularly and is expected, almost complete control is obtained by timely spraying with Bordeaux, Burgundy Mixture or one of the proprietary copper spray fluids. The object of the spraying is to protect the foliage from infection and to limit the spread of the disease. To achieve this end it is important that the spray should be applied before the disease appears. Spraying must be regarded as a prevention, not as a cure. When weather favours the Blight and an outbreak is considered likely, the first spraying should be done when the plants are about six inches high and subsequently at intervals of two to three weeks, in order that the new foliage may be protected. The grower must be guided by circumstances; if dry weather sets in and no more rain is expected, further spraying may not be necessary. It is possible that in this country spraying may be deferred until there is reason to believe an attack is impending. It is, of course, a counsel of perfection to spray as a matter of routine, and it is always a safeguard to do so, but it is appreciated that in certain seasons an epidemic is unlikely to occur and spraying may be a wasted effort. In squatter shambas certain native varieties of potatoes may be earlier than the main crop. These should be carefully watched and any signs of the disease here should be an indication of the desirability of spraying the main crop. Subsequent operations must be determined by the weather.

Copper-Lime and proprietary dusts are often advocated, as the costs per acre are considerably less than those of spraying, but dusts are, on the whole, considered to be less effective than spray fluids. However, when water is

Leaf showing types of leaf lesion; the lower leaflet has probably been infected by spores from the upper leaflets.
× *one-half approx.*

Plant attacked by Blight. The stem remains erect but all the leaves are affected, the majority being destroyed.
× *one-quarter approx.*

Diagram of conidiophores (spore-bearing part) of the fungus emerging through a breathing pore on the leaf surface.
× 200 *approx.*

Blight lesion, showing the white halo of mould on underside.
(*Natural size*)

difficult to obtain and labour must be economized, dusting is better than no spraying at all and may give satisfactory control if the epidemic is not very severe.

From 120 to 160 gallons of spray fluid and 20 to 25 lb. of dust are required per acre, according to the state of the crop.

While spraying is the most effective way of protecting the crop from Blight, other measures can be taken to protect the tubers and to reduce the chances of infection next season. The tubers are infected by the spores being washed down through the soil or by tubers coming into contact with fresh infected foliage at the time of digging. Keeping the crop earthed up will give the tubers a large measure of protection while the crop is still growing. The spores are known to be comparatively short-lived, so that if digging is delayed for a week or two after the haulms have died down the tubers are not likely to come into contact with living spores. To dig in wet weather when the haulms are at all green is to invite trouble, and the worst possible practice is to leave heaps of tubers covered with haulms in the field. In some countries the haulms are destroyed at the end of the growing season by spraying with copper sulphate or sulphuric acid. In this country it may be a good plan, where possible, to cut the haulms if they are badly attacked as, in any case, no further increase in crop will take place. These precautions apply only if the crop is to be stored or used for seed; they are, of course, unnecessary if the crop is to be consumed immediately after lifting.

There are occasions when it is necessary to dig potatoes while the haulm is still green and the tubers immature. This may occur when there is a demand for early shipment of seed potatoes. If no special precautions are taken, rot is likely to occur in transit, as spores from the unwithered haulms are certain to come into contact with the tubers during lifting. It has been found that loss can be almost entirely prevented by dipping the tubers in a disinfectant solution as soon as possible after they are lifted. Formalin, mercuric chloride, or proprietary mercury dips are usually employed. The object is to destroy the spores on the surface of the tuber; it is of no avail once infection has taken place.

Slightly infected tubers are likely to pass unnoticed at the time of digging, but the rot may progress in storage or during transit, and cause considerable loss. It is advisable to leave the tubers from an infected crop for a few days to sweat in a heap. If the heap is then picked over the blighted tubers can usually be detected and discarded. No infection of healthy tubers is likely to take place while this is being done.

As has been stated, the reappearance of Blight is believed to be due to certain slightly infected tubers being planted. These are easily overlooked at the time of planting, but can often be detected if sprouted in boxes before planting. Such infected tubers usually sprout prematurely and produce thin, spindly sprouts.

It is especially important in this country that infected tubers should not be left lying about. This is very likely to occur in the neighbourhood of stores, dumps, markets, etc. All must be regarded as a possible source of infection, and should be carefully collected and either buried deeply or destroyed.

As with most other diseases, the most satisfactory way of dealing with the disease would be the cultivation of immune varieties. Unfortunately, no immune varieties have been produced, although this has been the aim of potato breeders since the great outbreak of 1845. All that can be said is that some varieties are more resistant than others. Varieties have been produced, such as Magnum Bonum and Red Flourball, which were at one time highly resistant but after many years of cultivation have become more or less susceptible. The variety Evergood, however, is highly resistant to Blight, and has remained so for over thirty years. For this reason, in spite of certain undesirable qualities, it has been extensively grown in the Fen district of England, where Blight is always a serious menace. Much seems to depend on the particular strain, and on the conditions under which the variety is grown. Kerr's Pink, the favourite variety in Kenya, is said to be fairly resistant, but suffered badly during the last season.

The prospect of the breeding of a really highly resistant type is now much brighter. Recent expeditions to South and Central America have found species of wild potatoes immune to Blight, and hybrids of these with *Solanum tuberosum*, back-crossed for several generations, have shown promising commercial qualities. Of the so-called native varieties, some such as "Nyakinongo" and "Kiraya" appear to be resistant, at any rate much more so than Kerr's Pink, while others, such as "Misimaa" and "Nyakahoro", are very susceptible. These latter varieties should not be permitted in the vicinity of the main crop, as they may well become the starting point of an attack.

Preparation of Bordeaux and Burgundy Mixture

The formulæ in common use produce an alkaline solution containing 1.0 per cent copper sulphate, which is the strength commonly used for potato spraying in England. Stronger solutions up to 2.0 per cent can be used,, although there is very little difference in fungicidal value between the two; 0.8 per cent is the strength usually employed for other crops.

One per cent Bordeaux Mixture is made up in the following proportions:—

5 lb. copper sulphate,

5 lb. quicklime or 7 lb. hydrated lime,

50 gallons water.

The copper sulphate is dissolved, the milk of lime prepared separately, and the dilute liquids mixed to form the fungicide. The copper sulphate is easier to dissolve if it is powdered or granulated, but the crystals dissolve readily overnight if suspended in a bag in the water. Careful slaking of the lime is important. It should first be reduced to a powder by sprinkling with water. More water is gradually added to form a cream and finally a milk.

If it is proposed to make, say, 50 gallons, the copper sulphate is dissolved in a small quantity of the water and the milk of lime diluted with the balance. The concentrated copper sulphate solution is then poured slowly into the dilute lime solution. If the mixing is taking place in the spraying machine, the liquids should be put through a strainer. Authorities differ as to whether the concentrated copper sulphate should be added to the dilute lime or rice versa, or whether equal volumes should be mixed. In fact there are no fewer than seven combinations which give comparable results, and most have been recommended at times by various workers. Provided that concentrated solutions are not mixed and the mixture afterwards diluted, any one of the possible combinations can be adopted. It is, however, generally recommended to add concentrated copper sulphate to dilute lime solution.

In the preparation of large volumes of spray fluid it is convenient to prepare stock solutions by dissolving copper sulphate at the rate of 1 lb. to a gallon of water in one cask and lime at a similar rate in another. Both solutions will keep for a long time if the containers are kept covered.

To prepare, say, 40 gallons of spray fluid, 32 gallons of water are run into the tank. Four gallons of stock lime are added, followed by the slow stirring in of the four gallons of copper sulphate. Stock solutions must never be mixed and afterwards diluted.

If preferred, hydrated lime may be used in the place of quicklime, but it must be fresh. For making Bordeaux, 7 lb. of hydrated lime must be used to replace the 5 lb. of quicklime. Owing to the variable quality of the lime, it is always advisable to test the mixture for the presence of any free copper sulphate. This can be done by dipping a clean knife or nail into the mixture. If it remains bright after immersion for a minute or two the mixture is correct; if there is a deposit of copper, more milk of lime must be added. The mixture can also be conveniently tested by dipping into it a piece of blue litmus paper. If it turns red, milk of lime must be added until on testing the paper remains blue.

One per cent Burgundy Mixture.—This will probably be preferred in Kenya, owing to the difficulty of obtaining good quality lime and also because it is less troublesome to prepare. The proportions for a one per cent mixture are as follows:—

5 lb. copper sulphate,

3 lb. Magadi Soda (soda ash),

50 gallons water.

The same procedure as that for the preparation of Bordeaux Mixture is followed, the concentrated solution of copper sulphate being added to the dilute soda solution, or vice versa. The mixture should be tested for free copper sulphate in the same way, and more concentrated soda solution added if required, care being taken not to add an excess.

In the preparation of these mixtures the copper sulphate solution must not be allowed in contact with iron or zinc vessels. For this reason, if oil drums are the only large vessels obtainable, it is better to use them for holding a large volume of dilute lime or soda solution and to prepare a small quantity of concentrated copper sulphate solution in wooden, porcelain or enamel vessels.

Once mixed the fungicide should be used as soon as possible, as the precipitate deteriorates rapidly on keeping; a fresh supply should be prepared for each day.

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NOTES ON LEPTOSPERMUM CITRATUM

By Gilbert Walker, Nakuru

These notes describe an attempt to establish this tree on a plantation scale for its essential oil on a farm in Kenya.

The farm is in the Nakuru district and lies on the eastern side of the Great Rift Valley at an altitude of 6,600 feet, with a light, rather sandy, soil. It is used for the cultivation of essential oil plants and the distillation of their oil.

Leptospermum belongs to the order Myrtaceae. The genus is mentioned in Nicholson's Encyclopædia as comprising about twenty-five species of shrubs and trees, mostly native to Australia, where they, as well as some Melaleucas, are known as Tea (Ti) Trees. This popular name is said to have its source from the story that Captain Cook's seamen brewed a tea from the leaves of a species of *Leptospermum*.

L. citratum is a small tree indigenous to New South Wales and Queensland, but does not apparently occur in sufficient quantities for the economic distillation of its oil except on a small scale, and some years ago plantations were being put down in that country.

The oil contains citral and citronella, and in this respect takes a position somewhere midway between Cochin lemongrass and Java citronella, and although through its fresh and distinctive odour it finds a place in soap compounds and colognes, yet if produced in large amounts it would have to be sold for the manufacture of isolates and come into competition with the inexpensive "grass" oils, in the same way as would oil of *Eucalyptus citriodora*.

At first sight it would appear impossible for a tree which takes several years to grow up to rival the grasses which give a first crop within only a few months of planting, but since citronella and lemongrass do not thrive here, it was thought worth while trying, and after due consideration the *Leptospermum* was chosen for the experiment.

The first attempt was made at the end of 1936, but no germination took place, the very small seed having been sown in beds with no special precaution other than shading.

In July, 1937, I tried again. The seed germinated in from 16 to 18 days, the seedlings were pricked out into boxes in five months' time, and in another six months were six to eight inches high, and ready to be transplanted. They are delicate and slow in the early stages, and were found very susceptible to damping-off; large batches were lost time after time. However, my nursery boy, Wanjau, remained full of zeal and quite undismayed by the repeated disasters, and eventually our difficulties were largely overcome. Attempts to propagate by cuttings, from roots and by layering have not been a commercial success.

L. citratum is sometimes to be seen in gardens as an ornamental shrub, and in September, 1938, I noticed two trees in the Nairobi Arboretum. Through the courtesy of the Conservator of Forests I was able to gather from them sufficient material for a trial distillation. This consisted of 28 lb. of dark green mature leaves with a few small twigs and a considerable number of flowers and fruits. The flower buds, small white flowers and fruit are particularly rich in a fragrant oil, while mature leaves contain more oil than immature, and this no doubt (added to the fact that the sample had had time to dry out somewhat during the journey home) accounts for the high oil content of 2.56 per cent revealed on distillation.

Subsequently, I saw a sample of oil from trees in Kitale district, but it is not thought that the oil is being produced commercially anywhere outside of Australia, except here.

In order to study the growth of the trees, the first few were planted in three rows of 75 trees each, spaced 5 ft. by 4 ft. The outer row was left to grow untouched, the central row was used for experiments, and the third row for ordinary distillation; for the central row was considered the most useful for obtaining data as nearly as possible under plantation conditions, but it is now overshadowed by the outer row, which has grown to 10 or 12 feet high and started flowering last year.

Growth after planting in June, 1938, was rapid, and in December many trees were two feet high. In January, 1939, the weight of leaf from an average tree was 6 oz., in April 9 oz., and in November, two years and four months after the sowing of the seed, the leaves and twigs of the 75 trees in the central row were gathered and weighed 204 lb. and the oil content was 1.7 per cent.

Fresh growth came on apace, and in July, 1940, eight months later, a second cutting was made. The material weighed 420 lb., but the oil had fallen to 1.2 per cent; this may partly be due to the leaves being wet and heavy from a shower of rain and by the presence of a large number of young shoots.

In order to find out the effect of pruning back on the yield of leaf, blocks of ten trees each were cut down to different heights from the ground, i.e. to 1 ft., 1 ft. 6 in., 2 ft., 2 ft. 6 in., and 3 ft., and allowed to grow for twelve months. In spite of an exceptionally long

period of drought, growth was general; in three months the 1 ft. trees were covered with red shoots about 16 inches long, those of the 3 ft. trees being 9 inches, and two months later the lengths were 2 feet and 14 inches respectively. In July, 1941, a year after the cutting back, there was a new growth of 4 ft. throughout, and on gathering the leaves and twigs from these test trees the weights obtained were as follows:—

Trees cut back to 1ft., an average of 4.5 lb. per tree.
Trees cut back to 1ft. 6in., an average of 5 lb. per tree.
Trees cut back to 2ft., an average of 5.5 lb. per tree.
Trees cut back to 2ft. 6in., an average of 5.2 lb. per tree.
Trees cut back to 3ft., an average of 5.4 lb. per tree.

So that it seems that trees should not be pruned back to below 2 ft., although it might be best to cut them right back at least once in order to induce a shrubby growth, and perhaps this should be done when planting out.

The weather throughout these trials was very dry, and it is noteworthy that five trees in the outer unpruned row died, presumably from drought, while the pruned trees did not suffer.

Meanwhile a plantation of six acres had been established in June, 1939, and it has been considerably multiplied since then. In order to try and keep down weed growth and grass, the trees were spaced 4 ft. by 4 ft. only.

The first commercial distillation was made in September, 1940, and 371 lb. of oil were taken from the six acres. When the inevitable misses are taken into account, together with the unfavourably dry weather, the result was not unexpected.

Another distillation from this same section in six months' time was disappointing; the mistake was made of harvesting before the new growth had matured. The very numerous young shoots are a reddish colour, and distillation should not be done at any rate before the general hue of the plantation has turned from a pink copper to a copper green, and possibly not even for a long time after that. A recent first distillation from another section of plantation has produced 158 lb. per acre.

Although the period between distillations must necessarily vary with the weather, the indications are that they should not be made at intervals of less than eight months, but it will take several years of study before useful data on that and other kindred subjects are obtained.

The leaf is narrow and small, and it is impracticable to strip the leaves from the twigs and ends of branches, which have to be cut and sent to the still with the leaves. A large amount of labour is required for the gathering of them. With a two to two-and-a-half-hour distillation it takes sixty boys cutting all day to keep two of my stills at work for five hours a day only, each boy gathering some 180 lb. of material a day. This is not economical, so that it was desirable to find out the effect of drying the leaf. A quantity of leaves and twigs were cut and a test showed an oil content of 1.44 per cent. Three hundred pounds of the material was then dried for three weeks in a building roofed with galvanized iron. On distilling, the yield of oil was found to be 1.46 per cent of the green material.

Another experiment was made later with sun-drying out of doors for five days. The green material contained 1.68 per cent of oil, while the yield from the dry material was found to be 1.62 per cent, calculated on green basis. During the process of sun-drying the weight of leaves and twigs was reduced by 50 per cent, and the still was able to hold a larger charge of the dry leaf.

From this it appears that the leaf could be dried and stored until a sufficient quantity was ready to keep the stills working full time.[1]

Like other essential oils which are so frequently over-produced, the price of citronella varies greatly. In recent years, before the war, it has been down to 1/- per lb. in London. This is said to be unprofitable, and no suggestion is made that *Leptospermum citratum* could pay in such circumstances, but its possibilities, in spite of the difficulties of establishing a plantation, are not inferior to those of the "grass" oils of commerce, and that is what I had wished to find out—whether a plantation of trees with a high yield of oil can be worked in competition with the quick-growing lower-yielding grasses in native hands in other countries. Since the war, prices have risen, and oil is regularly being exported from our plantations.

The Imperial Institute, as a result of the analytical examination of two samples, found that the oil possessed constants which, except for solubility in alcohol, fell within the range indicated by Penfold for the Australian oil, and my thanks are due to them for their helpful advice and interest in the work.

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[1] The Senior Agricultural Chemist, Kenya, has determined the aldehyde content—by the hydroxylamine method—of the oil distilled from the green material and of that from the dried material, the figures being respectively 80.9 per cent and 81.5 per cent, calculated on the basis of citral.

A LOWER PROTEIN RATION FOR FATTENING BACON PIGS

By M. H. French, Ph.D., M.A., Dip. Agric. (Cantab.), Veterinary Laboratory, Mpwapwa, Tanganyika Territory

In East Africa there are two main sources of animal protein available for pig feeding, namely separated milk and meat meal. The majority of pig farmers in Tanganyika have insufficient separated milk for this purpose and are consequently forced to rely on meat meal imported from Kenya. Now transport charges are very high, with the result that meat meal is an expensive item in the pig dietary.

For many years farmers attempted to overcome this problem of obtaining a cheap protein food by feeding only foodstuffs of vegetable origin. The result has been that their pigs grew slowly, consumed large quantities of meal during the fattening period, and yielded poor carcasses which contained too much fat and fat which was too soft and tended to become yellow and rancid on storage.

Experiments were carried out at Mpwapwa and it was quickly shown that—

(*a*) Carcasses from pigs fed no animal protein lacked finish, had a less well-developed muscular system, a lower percentage of sides and hams, a higher percentage of secondary offals, and a softer fat (higher Iodine Value).

(*b*) Pigs fed on rations containing meat meal completed their fattening, i.e. attained 200 lb. live weight, with a total food consumption which was 20 per cent less than when rations containing no animal proteins were fed.

(*c*) Separated milk, added to a ration containing no other animal proteins, was just as effective as meat meal in reducing the total amount of food needed to complete fattening. This reduction of 20 per cent is far greater than can be accounted for by the milk solids fed.

(*d*) Separated milk stimulates appetite and thereby increases the rate of fattening.

It is therefore obvious that whilst pigs can be fattened on locally produced vegetable foods, a quicker and more economic conversion of food into bacon and a better quality of bacon result from the use of animal protein foods. In any bacon industry it is essential that (*a*) the right type of pig be fattened, (*b*) the pig should be correctly fed, and (*c*) the carcass should be properly cured. Failure to comply with any of these conditions will jeopardize the success of the industry. Since the omission of animal proteins from the diet of fattening pigs in this Territory reduces the quality of the product, there is indeed a very strong reason why those connected with the welfare of the industry should insist on the feeding of a certain amount of animal proteins.

As already pointed out, the majority of Tanganyika pig farmers are forced to purchase expensive imported meat meal, and the problem of reducing the quantity fed to the necessary minimum becomes urgent, otherwise the farmers' profits may suffer. The experiments described below were undertaken with this object.

A short while ago it was shown by Cambridge workers [2] [3] [4] that the normally accepted standards of protein requirements of bacon pigs were unduly high. These workers showed that neither the economy or rate of live-weight increase nor the quality of the resulting carcasses were affected by feeding half the protein usually regarded as necessary. Crowther [5] recently reviewed the feeding standards suggested for bacon pigs by Cambridge, Harper Adams and Scandinavian workers, and the following table of suggested requirements has been drawn up from the figures given by Crowther:—

TABLE I

SUGGESTED FEEDING STANDARDS FOR FATTENING PIGS

Live weight of pigs	Weight of meal consumed daily	Amount of total protein required daily	Protein content of meal to meet the protein requirement
Lb.	*Lb.*	*Lb.*	*Per cent*
30	1·6	0·320	20·0
40	2·1	0·375	17·8
60	3·0	0·460	15·3
80	4·0	0·545	13·6
100	4·6	0·615	13·4
120	5·3	0·660	12·5
140	5·9	0·690	11·7
160	6·45	0·720	11·2
180	6·7	0·740	11·0
200	7·0	0·750	10·7

In arriving at these figures, Crowther assumed that normal pig mixtures have a starch-equivalent value of 65 per cent, and, provided no unusual foodstuff is included in the ration, no great error is likely to be encountered. The figures for total protein requirements have been obtained by assuming an average protein digestibility of 75 per cent in the food mixtures.

Although these figures are suggested as representing the latest ideas concerning pig requirements, they must not be interpreted as accurately determined constants which must be followed blindly. They represent the best guide a stockman can find for pigs of the Large White type, but he must still be prepared to adjust the standard to his own conditions and to provide for minerals and vitamins which are not included in the standards.

In this Territory, largely with a view to standardizing the bacon quality, the Large White breed has been encouraged, and most up-to-date farmers breed nothing else. Therefore it was thought that Crowther's standards would be easy to apply to Tanganyika conditions and rations were drawn up on this basis and tested out with individually fed pigs, with group-fed pens, and under ordinary commercial conditions. A modified scale of feeding was adopted and, as shown in Table II, there are fewer changes in the ration than strict adherence to Crowther's standards would imply; and it is perhaps as well to point out again that though Table II suggests a change in the ration mixture at 60 lb. live weight, it does not mean that the pigs have to be weighed on scales and the mixture altered on the day the pigs reach 60 lb. It is sufficiently accurate in commercial practice to estimate weights "by eye" if no weighbridge is available, and it will not matter if the ration is not changed on the day the pigs reach 60 lb. This is the ideal to aim at; circumstances will modify procedure. I have stressed this minor point because this has been one of the criticisms raised against any suggested standards by farmers in this country.

TABLE II
STANDARDS ADOPTED IN TANGANYIKA TRIALS

Live weight of pigs	Weight of meal to be fed daily	Protein content of meal mixture
Lb.	*Lb.*	%
30–60	1·6–3·0	18·0
60–90	3·0–4·3	15·0
90–120	4·3–5·3	13·0
120–150	5·3–6·2	12·0
150–200	6·2–7·0	11·0

The actual meal mixtures eventually decided upon are shown in Table III, and were designed to utilize only those foodstuffs which are readily obtainable at economic prices in the Southern Highlands. The protein contents of these rations are about 10 per cent higher than those required by Table II, but this could not be avoided without introducing many odd numbers in the various proportions, and, since these rations have to be mixed by natives, the less complicated the proportions the more likely they are to be followed correctly.

TABLE III
MIXTURES OF FOODSTUFFS USED IN TRIALS

Mixture No. ..	*I1*	*I2*	*I3*	*I4*	*I5*
For pigs of live weight ..	*Lb.* 30–60	*Lb.* 60–90	*Lb.* 90–120	*Lb.* 120–150	*Lb.* 150–200
	%	%	%	%	%
Meat meal ..	12·5	8	6	3	2
Wheat bran ..	25	30	30	30	30
Barley meal ..	—	—	—	10	20
Maize meal ..	60	59	61	54	45
Lime	2	2	2	2	2
Salt	0·5	1	1	1	1

Barley does not grow near Mpwapwa but has to be transported from a considerable distance. Owing to transport delays during the wet season, the barley ordered for the main trial did not arrive in time, so that in most cases described below the barley in the ration from 120 lb. onwards was replaced by maize meal. This reduced carcass quality, particularly the nature of the fat, but did not affect the protein contents of the rations appreciably.

INDIVIDUAL PIG-FEEDING TRIALS

Pig 36 was fed the rations as set out in Table III, including barley meal, from 32 to 206 lb. live weight.

Pig 38, a litter-mate of pig 36, was fed from 31 to 207 lb. live weight the ration which had previously been found to give the best results at Mpwapwa. This was composed of maize meal 60 per cent, wheat bran 15 per cent, cowpeas 15 per cent, meat meal 8 per cent, lime 2 per cent, and salt 1 per cent, and contained approximately 18 per cent total protein. No change was made in the nature of this ration as fattening proceeded.

Pig 42, from another litter, was fed from 82 to 204 lb. live weight the rations in Table III, but with maize meal replacing barley meal.

Pig 43, a litter-mate of pig 42, was fed from 77 to 189 lb. live weight on the rations in Table III, but with the barley meal replaced by groundnut cake.

Pigs 44 and 45, from a third litter, were fed from 60 to 200 lb. live weight on the same mixtures as given to pig 42.

If the results of pigs 36 and 38 are set out as in Table IV, it is seen at once that the modified ration based on Table III is just as good as the previous best used at Mpwapwa. The new rationing allows a slightly higher rate of live-weight increase to be made at the same level of food conversion.

TABLE IV
LIVE WEIGHT GAINS AND FOOD UTILIZATION

	Pig 36	Pig 38
Initial weight	32 lb.	31 lb.
Final weight	206 lb.	207 lb.
Live weight increase	174 lb.	176 lb.
Number of days	129	144
Gain per day	1·35 lb.	1·22 lb.
Food consumed	561·5 lb.	563·25 lb.
Food consumed per lb. live weight increase	3·22 lb.	3·20 lb.

If the details of the rations eaten are calculated it is seen that, on the old ration, pig 38 ate 25 per cent more total protein and 67 per cent more meat meal than pig 36 on the new scale. The cost of fattening pig 38 was from 15 to 20 per cent more than for pig 36. Also, as will be seen later, pig 36 had slightly better carcass measurements with a harder carcass fat.

Pigs 42 and 43 were much older when they were received for experimentation than Nos. 36 and 38, and pigs 44 and 45 were at an intermediate age. In Table V I have re-calculated the data from pigs 36 and 38 to cover the same range of live-weight increase as for pigs 44 and 45. The data from pigs 42 and 43 are from slightly heavier pigs and are not quite comparable with the others in Table V, but are included because of their general confirmatory nature.

The food consumption per lb. of live-weight increase for pigs 36 and 38 is higher than in Table IV, as would be expected from the later stage of growth and fattening. It is also seen that pigs 44 and 45 compare well with pig 36 in rate of live-weight increase and economy of food conversion.

TABLE V
LIVE WEIGHT GAINS AND UTILIZATION (LB.)

	Pig 36	Pig 38	Pig 42	Pig 43	Pig 44	Pig 45
Initial wt.	63·5	60·5	82·0	77·5	59·5	60·5
Final wt.	206·0	207·0	204·0	189·0	200·5	207·5
Live weight increase	142·5	146·5	122·0	112·5	141·0	147·0
Number of days ..	95	102	88	82	98	91
Gain per day ..	1·50	1·44	1·39	1·37	1·44	1·62
Food consumed	491	484·5	452·25	428·5	508·75	486
Food consumed per lb. live weight increase	3·44	3·31	3·71	3·81	3·61	3·31

The replacement of barley meal by maize meal did not affect the efficiency of the ration for growth and fattening, although it made the carcass fat softer.

The results obtained with the older pigs 42 and 43 agree satisfactorily with those from the other pigs, and it appears that the substitution of barley meal by groundnut cake in the ration of pig 43 was not an advantage. This pig actually showed the slowest rate of live-weight increase and the highest food consumption per lb. live weight gained, in spite of the fact that he was killed at the smallest weight. As was to be expected, the inclusion of cake at this late stage had no beneficial influence on the carcass proportions, but merely made the fat softer than when barley meal was used.

GROUP FEEDING TESTS

Three pens of six pigs were fed on this new scale of rationing, but in each case the barley meal had to be replaced by maize meal. Pens 2 and 3 were fed a ration containing wheat bran as recommended in Table III, but in the ration of Pen 1, pollards replaced the wheat bran. Table VI summarizes the results.

TABLE VI
LIVE WEIGHT GAINS AND FOOD UTILIZATION (LB.)

	Pen 1	Pen 2	Pen 3
Average initial weight ..	90·1	75·2	54·5
Average final weight ..	205·6	202·6	170·9
Average live weight gain	115·5	127·4	116·4
Number of days ..	84	91	91
Average gain per day ..	1·37	1·40	1·28
Average food consumption	471	513	454
Average food consumption per lb. live weight gain	4·08	4·03	3·90

Although pollards are a more expensive food than wheat bran, there is no indication from this trial that they form a more efficient fattening food for pigs.

Owing to wastage of food from the feeding troughs, it is only to be expected that the economy of food conversion will be lower in group-fed pigs than under the more carefully controlled conditions of the individual feeding technique. If allowance is made for this, it is seen that the new rationing standards allow a satisfactory rate of live-weight increase to be attained at an economic level of food conversion.

As would be expected from the high proportion of maize in the diet, the quality of the carcass fat was not so high as when barley meal was fed.

COMMERCIAL PRACTICE

This new rationing plan was put into operation by the Agricultural Officer in charge of the commercial pig unit at Iheme, and the results were entirely satisfactory. All pigs sent

to the factory after being fattened according to the scale in Table II yielded first-grade carcasses.

Carcass Measurements

Tables VII and VIII give the linear and weight measurements of the carcasses from these pigs.

TABLE VII
Carcass Measurements

	Length, ins.	Shoulder Fat thickness, cm.	Loin fat thickness, cm.	Mean rump fat thickness, cm.	Mean belly thickness, cm.	Loin muscle depth	Loin muscle length
Pig 36 ..	31·25	4·3	2·3	3·3	3·8	4·2	9·2
Pig 38 ..	30·75	4·5	2·4	3·3	3·6	4·1	9·1
Pig 42 ..	31·5	4·5	2·3	3·2	3·0	4·5	9·0
Pig 43 ..	31·3	4·2	2·0	2·9	2·9	4·2	8·7
Pig 44 ..	30·5	4·8	2·4	3·4	3·3	4·0	9·4
Pig 45 ..	31·75	4·8	2·5	3·2	3·6	4·2	9·3
Average of pens 1, 2 and 3	31·1	4·5	2·3	3·1	3·6	—	—

These measurements are considered quite satisfactory, and it is interesting to compare them with figures given in Table VIII, page 202, in 1939 Annual Report (Part II) of this Department (not yet published). There has been an improvement in belly thickness in the present series, and it is thought that this is due more to breed improvement than to the rations used. The lower protein diet suggested in Table II has obviously not affected the muscular development, as judged by the measurement of the psoas muscle, a finding which is in complete agreement with recent work in England. The quantity of fat, as judged by back-fat measurements, is about correct for a bacon pig of 200 lb. live weight, and suggests that the present strain of Large White pig is capable of yielding a finished carcass at 200 lb. live weight. Slaughtering at lower weights will probably, as suggested by the data from pig 43, give unfinished carcasses with insufficient fat on the later maturing parts (rump and loin).

TABLE VIII
Carcass Weights and Percentages

	Pig 36	Pig 38	Pig 42	Pig 43	Pig 44	Pig 45	Average of Pens 1, 2, and 3
Carcass as percentage of live weight	77·9	78·9	77·2	75·3	77·1	78·4	79·0
Head, feet, kidneys and leaf fat as percentage carcass ..	15·5	15·1	14·4	15·5	15·7	15·7	—
Weight of head in lb. ..	17·0	16·8	17·5	15·8	17·5	18·9	16·1
Weight of liver in gm. ..	1,262	1,440	1,442	1,347	1,400	1,507	1,200
Weight of alimentary canal in lb.	10·5	10·0	10·2	9·8	10·8	11·8	10·2

Again there is no indication that the lower protein ration has had any adverse effect upon the weights of the more important offals or on the carcass yield.

Summary

(1) Reducing the quantities of total protein in the ration of fattening pigs to the standards given in Table II has had no unfavourable effect on the rates of live-weight increase and food conversion, nor upon the muscle-fat ratio of the final carcass.

(2) A considerable saving of protein foods can be effected, particularly of the expensive meat meal, with a corresponding reduction in the costs of fattening.

(3) This result has been obtained with pigs fed (*a*) individually, (*b*) in groups, and (*c*) in a commercial pig unit.

(4) If barley meal is not available and maize meal replaces it in the rations given in Table III, then a softer carcass fat is produced, but the rate of live-weight increase and the efficiency of food conversion are not affected.

(5) Reducing the proteins intake of fattening pigs to the levels suggested in Table II is strongly recommended, provided a fair proportion of animal protein be included.

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THE DURABILITY OF SOME UGANDA TIMBERS AND POLES IN THE GROUND

PART II

By R. G. Sangster, B.Sc., Assistant Conservator of Forests, Uganda

Section II—Small Poles

These were poles of a type suitable for Africans' houses and small temporary buildings. They were tested for two to three years.

TABLE II

UNTREATED POLES

SUMMARY OF ASSESSMENTS IN PERCENTAGE FAILURES

SPECIES	No. of pieces	PERCENTAGE FAILURES AFTER MONTHS							REMARKS
		6	10	16	21	24	30	36	
Acacia decurrens Willd. WATTLE..	20	—	25	65	70	100	×	×	Poles split badly to admit fungus; termites followed.
Agave sp. SISAL	20	80	100	×	×	×	×	×	Useless as a pole in the ground.
Albizzia zygia (D.C.) Macbride ..	20	5	25	25	30	45	×	×	Rot primary.
Cassia siamea Lam.	20	—	55	60	65	75	×	×	Rot primary, termites secondary.
Casuarina equisetifolia Forst. ..	20	50	85	85	85	85	×	×	Termites primary, rot secondary.
Cedrela toona Roxb.	20	5	15	20	75	90	×	×	Rot and termites equally injurious.
Combretum binderanum Kotschy ..	20	—	5	5	15	40	45	90	Rot primary, termites secondary.
Combretum queinzii Sond.	20	10	10	10	50	80	×	×	Rot primary.
Cupressus lusitanica Carr. ..	20	—	20	25	50	65	×	×	Termites attacked early but most failures due to decay.
Dalbergia melanoxylon Guill. & Perr.	19	—	—	—	—	—	×	×	Sapwood of all pieces rotting; heartwood sound.
Eucalyptus robusta Sm.	20	50	90	90	100	×	×	×	Termites primary; rot final.
Eucalyptus saligna Sm.	20	60	70	80	95	100	×	×	Termites primary; rot final.
Ficus natalensis Hochst.	20	40	50	55	60	65	×	×	Termites and rot equally injurious. Borer often combined with rot.
Grevillea robusta A. Cunn. ..	20	40	80	100	×	×	×	×	Termites primary.
Hexalobus monopetalus (A. Rich. Engl. & Diels	18	—	—	—	—	50	×	×	Rot sole cause of failure.
Hymenocardia acida Tul.	10	—	—	—	10	40	50	×	Rot sole cause of failure.
Jacaranda ovalifolia R. Br. ..	20	—	10	25	45	75	×	×	Termites attacked early but most failures from rot.
Lasiodiscus mildbraedii Engl. ..	20	—	—	—	—	—	25	65	Rot primary; termites secondary.
Markhamia platycalyx Sprague ..	20	—	—	—	5	65	×	×	Rot primary; termites secondary.
Melia azedarach L...	20	40	85	90	95	95	×	×	Termites main cause of failure; rot helped.
Phoenix reclinata Jacq.	20	—	5	30	85	85	×	×	Rot primary; termites secondary.
Teclea nobilis Del.	20	—	—	—	10	25	45	90	Rot primary; termites secondary.
Terminalia brownii Fresen. ..	20	—	—	—	—	—	×	×	Termites attack has started on three pieces and borer above ground on one.
Ziziphus mauritiana Lam. ..	20	—	—	5	25	45	70	×	Rot primary.

That none of the specimens show the durability of squared timbers is to be expected, and when the rapid failure of some species is considered in the light of practical experience (notably the *Markhamia* and the *Phoenix*),[1] the severity of the test can be appreciated. The extreme conditions of wetting and drying, and of heating and cooling, are never encountered in buildings, and were we to apply the results of the test literally we should never use any of these poles for buildings which we wished to last (with minor repairs) for even two years.

From mere consideration of the figures it is impossible to recommend any of the poles. Even the ones which have not failed in the first two years may follow the course of *Lasiodiscus mildbraedii*, and suddenly deteriorate in the third. Does anything in the cause of the failures offer any hope?

[1] In a private communication, the Conservator of Forests, Uganda, says: "It has been suggested to me that there may be difference in durability between male and female *Phoenix* palm (Lukindu). I was also informed that there was a difference in the length of the nodes in the sexes. In view of the surprisingly poor results with this species, this might be worth investigation."

We are dealing with two factors, termites and rot, and the data in Table II distinguish failure due mainly to one or the other or arising from a combination of the two. It is interesting to find that of the species deteriorating most rapidly the majority owe their failure solely or in the main to termites. This applies to four of the five species showing 65 per cent failures in ten months, five of the six species with more than 75 per cent failures in sixteen months, and five of the seven species with more than 85 per cent failures in twenty-one months. This distinction becomes obscure when a longer period is considered. For example, out of the nine species with over 85 per cent failures in twenty-four months, termites were primary in only five. Rot was primary in two and rot and termites combined in the remainder.

Certain species therefore are immediately attacked and demolished by termites and these are unworthy of consideration for use in contact with the ground. Unless preservatives are used—a measure at present usually out of the question on account of expense—they are bound to perish rapidly.

Other species are only eaten after some time, and in their case there is every indication that an initial period of rot is required to make them vulnerable. These offer possibilities for use in temporary works, since if they receive reasonable protection from the factors causing rot (i.e. extremes of moisture and dryness, and of heat and cold) they will in some degree become more resistant to termites also. The very fact of enclosure in buildings provides a certain amount of protection, and used in this way poles would last longer than in the "graveyard". This also applies to the two species which failed solely on account of rot.

We are now in a position to make recommendations based on consideration of the causes of failure.

A—Recommended

Rot alone caused failure of *Hexalobus monopetalus* and *Hymenocardia acida,* both of which, moreover, have shown comparative durability. They are therefore recommended for trial in buildings.

Further recommendations are *Albizzia zygia, Combretum gueinzii, Lasiodiscus mildbreaedii, Markhamia platycalyx, Teclea nobilis,* and *Ziziphus mauritiana,* in whose destruction termites were very subsidiary. These species have therefore a fair expectation of life in favourable circumstances.

Dalbergia melanoxylon and *Terminalia brownii* have a good record for the two years during which they were tested, and can also be recommended. The former species, unfortunately, is so scarce that for practical purposes it must be ignored.

Albizzia zygia (DC.) Macbride; *Nongo, Murongo* (Lunyoro, Luganda); *Owak* (Acholi); *Ebata* (Luteso).

Spreading deciduous tree, attaining 100 feet in forest, 40 feet in savanna.

Found in Mengo, Entebbe, Sesse, Mubende, Toro, Bunyoro, West Nile, Madi, Acholi, Teso, Budama, Busoga.

Combretum binderanum Kotschy; *Mukora* (Lunyoro); *Okecu, Odugo* (Acholi); *Ekulonyi* (Luteso).

Savanna bush or tree to 30 feet. The commonest savanna tree in Uganda.

Found in Mengo, Mubende, Bunyoro, West Nile, Madi, Acholi, Lango, Teso, Karamoja, Bugwere, Budama, Bugishu, Busoga.

Combretum gueinzii Sond.; *Muramma* (Lunyoro); *Okecu, Oduk* (Acholi); *Ekworo* (Luteso); *Ndawa* (Lusoga).

Found in Masaka, Ankole, Toro, Mubende, West Nile, Acholi, Lango, Teso, Karamoja, Bugwere, Budama, Bugishu, Busoga.

Dalbergia melanoxylon Guill. & Perr., African Blackwood (trade name); *Mufunjo* (Lunyoro); *Motangu* (Luganda); *Poyi* (Madi).

Found in Bunyoro, West Nile, Madi, Acholi, Karamoja, Bugishu. Rare.

Hexalobus monopetalus (A. Rich.) Engl. and Diels; *Rota* (Madi).

Savanna tree to 20 feet high, much in demand for hut-building in West Madi.

Found in Bunyoro (Fajao), West Nile, Madi, Acholi.

Hymenocardia acida Tul.; *Ebilaboni, Eterugu* (Luteso); *Mutatatankubebe* (Lunyoro); *Okang, Okango* (Acholi); *Okongo* (Lango); *Mukanaga* (Lusoga).

Twisted savanna shrub or tree, usually under 15 feet high, sometimes as much as 30 feet.

Found in Mengo, Mubende, Bunyoro, West Nile, Madi, Acholi, Lango, Teso, Bugishu, Bugwere, Budama, Busoga.

Lasiodiscus mildbraedii Engl.; *Munyamaija* (Lunyoro).

Small under-storey tree associated in the Budongo Forest with *Cynometra alexandri* (*Muhimbi*). Straight poles over 10 feet are difficult to obtain. This species is much sought by Banyoro for building.

Found in Mengo, Masaka, Bunyoro.

Markhamia platycalyx Sprague; *Nsambya Lusambya* (Luganda).

Tree to 40 feet, rarely 60 feet. Frequently planted by Native Administrations, and occurring naturally in forest.

Found in Mengo, Masaka, Sesse, Entebbe, Ankole, Toro, Mubende, Bunyoro, West Nile, Madi, Busoga.

Teclea nobilis Del.; *Nzo* (Luganda); *Muzo* (Lunyoro).

Found in Mengo, Entebbe, Sesse, Masaka, Ankole, Kigezi, Toro, Mubende, Bunyoro, Madi, Acholi, Lango, Teso, Karamoja, Budama, Bugishu, Busoga.

Terminalia brownii Fresen.; *Kilere* (Acholi); *Malere* (Madi); *Museta* (Lunyoro).

Tree to 50 feet, occurring in dry savanna and on mountain slopes up to 7,000 feet, frequently in very rocky situations.

Found in Toro, Bunyoro, West Nile, Madi, Acholi, Karamoja, Bugishu.

Ziziphus mauritiana Lam.; *La* (Lugbara); *Okodokodwoyi, Elisang* (Luteso); *Lango, Olango* (Acholi); *Ngora* (Ludama).

Thorny savanna tree or shrub, sometimes erect to 25 feet, most often scrambling.

Found in Mengo (Bulemezi), West Nile, Madi, Acholi, Lango, Teso, Karamoja, Budama, Busoga.

B—Doubtful

Although rot was the primary cause of failure of *Cassia siamea, Cupressus lusitanica, Jacaranda ovalifolia* and *Phoenix reclinata,* their deterioration was so rapid that they could not justifiably be classed as "recommended" without further test.

Rot and termites were equally active on *Ficus natalensis, Cedrela toona* and *Acacia decurrens,* and it is impossible to say whether protection from rot would increase their resistance to termites and therefore lengthen their durability.

Acacia decurrens Willd. (Wattle), *Cassia siamea* Lam., *Cedrela toona* Roxb., *Cupressus lusitanica* Carr., and *Jacaranda ovalifolia* R. Br., are all exotics extensively planted in Uganda, the first three chiefly in Native Administration plantations for utility, the others in estates and stations for decoration.

Ficus natalensis Hochst. (*Mutuba,* Luganda) and *Phoenix reclinata* Jacq. (*Lukindu,* Luganda; *Musansa,* Lusoga; *Itchi,* Madi) are two indigenous trees widely known in Uganda, the former being in great favour with Africans for supplying bark-cloth; the latter, a palm found in swamps throughout the Protectorate.

C—Not Recommended

Agave sp. (Sisal), *Casuarina equisetifolia* Forst., *Eucalyptus robusta* Sm., *E. saligna* Sm., *Grevillea robusta* A. Cunn. (Australian Silky Oak), *Melia azederach* L. (*Lila* or *Lira*). All of these are exotics.

Section III—Large Poles

Two *Celtis* species (*Mukomakoma*) which were tested stand in a class by themselves as poles on account of their size, which suggests their use as telegraph poles or in fairly heavy temporary works.

Untreated *Celtis zenkeri* can be classed among the "recommended" poles, while untreated *Celtis soyauxii* falls into the "doubtful" group. Treatment with creosote and the mixture of creosote and paraffin has a marked effect on both. The numerous small cracks which develop as poles dry out after barking doubtless assist penetration, which is particularly rapid when the timber is boiled in the preservative. While the number of test pieces is perhaps too small to give conclusive results, there is good reason to believe that treated *Celtis* will be very useful for pylons, bridges and other heavy structures. Charring, it will be noticed, hastened failure.

Celtis soyauxii Engl.; *Bolwe* (Kwamba); *Lufugo* (Luganda); *Mukomakoma* (Lunyoro).

A straight-boled forest tree 100 feet high, clean for 40 to 60 feet, 5 to 8 feet in girth above the buttress.

Found in Mengo, Bunyoro, Toro (rare), Busoga.

Celtis zenkeri Engl.; *Mukomakoma* (Lunyoro).

Very similar to the above.

Found in Mengo (Mabira Forest), Toro (Bwamba), Bunyoro (Bugoma and Budongo Forests).

Conclusions

It must be repeated, before coming to any conclusions, that the conditions of the "graveyard" test are limited, in that while the elevation, rainfall and conditions of topography and soil are representative of a very large area, they do not occur through the whole Protectorate. Furthermore, the test was a very rigorous one. The specimens were exposed to rain and extremes of climate, and to unhindered attack from termites. Timber used in buildings is afforded a reasonable amount of shelter and is frequently protected from termites by the removal of all nests near by.

Considering, therefore, that the life of squared heartwood in the "graveyard" is shorter than might be expected in actual use, it is possible to recommend for trial those species

TABLE III

LARGE POLES, TREATED AND UNTREATED

SUMMARY OF ASSESSMENTS IN PERCENTAGE FAILURES

NOTE.—Pieces were 7 feet long with only the submerged 33 inches covered by preservatives.

TREATMENT	No. of pieces	PERCENTAGE FAILURES AFTER—MONTHS				REMARKS
		15	18	21	24	
(*a*) *Celtis soyauxii* Engl.:						
Untreated	15	—	—	40	75	Rot entered numerous cracks and was finally aided by termites.
Charred	10	—	10	10	100	Rot followed by termites.
Creosote (Applied hot in open tank)	10	—	—	—	—	40 per cent perfectly sound, rest damaged by rot *above* treated portion.
Creosote and paraffin in equal parts (Applied hot in open tank)	3	—	—	—	—	100 per cent perfectly sound.
Creosote and paraffin in equal parts (Brushed on cold) ..	7	—	—	—	—	None absolutely sound.
(*b*) *Celtis zenkeri* Engl.:						
Untreated	15	—	—	10	15	Rot entered cracks, later termites caused failure.
Charred	10	—	—	—	100	Rot primary; termites secondary.
Creosote (Applied hot in open tank)	10	—	—	—	—	100 per cent remain perfectly sound.
Creosote and paraffin in equal parts (Applied hot in open tank)	3	—	—	—	—	100 per cent remain perfectly sound.
Creosote and paraffin in equal parts (Brushed on cold) ..	7	—	—	—	—	75 per cent perfectly sound, rest damaged by rot *above* treated portion.

which have been consistently good throughout the period of the test. These are *Albizzia coriaria, Chlorophora excelsa, Cynometra alexandri, Erythrophleum guineense,* and *Mildbraediodendron excelsum.*

Preliminary trials with preservatives on some of the weaker timbers has met with success, and boiling in creosote (or mixed creosote and paraffin) is suggested for localities where the "recommended" timbers are not readily available.

In recommending small poles for use in contact with the soil it may be said that few, if any, of the species tested will give satisfactory results in conditions similar to those of the "graveyard" for more than two years. It is known, however, that rot is a primary cause of most failures, sometimes the sole cause, and that it frequently paves the way for attack and demolition by termites. While we cannot safely recommend any of the small poles for permanent outside work, we can, taking into consideration the protection afforded by shelter and shade, suggest several species for trial in buildings. These are *Albizzia zygia, Combretum binderanum, Combretum gueinzii, Dalbergia melanoxylon, Hexalobus monopetalus, Hymenocardia acida, Lasiodiscus mildbraedii, Markhamia platycalyx, Teclea nobilis, Terminalia brownii* and *Ziziphus mauritiana,* most of which are well known throughout the Protectorate.

Untreated *Celtis zenkeri* can also be recommended for buildings. When treated by boiling in creosote or mixed creosote and paraffin, both *Celtis zenkeri and Celtis soyauxii* are well worth trial in heavy structures.

These conclusions must be regarded as preliminary only, but they do indicate species which are worth trying and what improvements can be effected with the use of preservatives. Tests are being continued with the more durable timbers and poles discussed above and with other less-known species.

It is desirable that in due course fresh evidence should be published to confirm or disprove the conclusions set down in this paper.

It is suggested that future tests of small poles should be made in huts where conditions nearer to the normal use of the specimens might be approached and results made directly applicable.

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MODERN METHODS FOR THE CONTROL OF MOSQUITOES AND MALARIA*

PART I

By G. H. E. Hopkins, M.A., Senior Entomologist (Medical), Uganda Protectorate

Recent letters in the correspondence columns of the East African Press have shown a very welcome increase of public interest in the question of the control of malaria, coupled with a great deal of misunderstanding of the subject. Some of the letters are almost perfect illustrations of the proverb "A little learning is a dangerous thing"; statements from scientific articles having been partly misunderstood and partly accepted as gospel when the assertions have actually no sufficient basis of proof. In these circumstances it seems that a few simple notes on the subject may serve a useful purpose.

Mosquito-control in East Africa is concerned chiefly with control of the mosquitoes which transmit malaria (Anophelines) and those which transmit yellow fever. As recent pamphlets issued by the various Medical Departments deal fully with the latter problem, I propose to confine myself to the control of malaria, only stating that the two problems are entirely different and that only a very few of the measures we can take to prevent malaria have the slightest bearing on yellow fever; these few exceptions are those concerned with personal protection.

Even with this limitation the subject is a huge one, and it is not possible to deal exhaustively with it in an article of reasonable length. I propose to discuss it briefly under the headings: Personal Protection, Measures against Adult Mosquitoes; Naturalistic Measures against Larvæ, and Artificial Measures against Larvæ, though it must be noted that these divisions are not sharp; some of the measures discussed under one heading could equally well come under another. It will not be possible, within these limits, to do much more than to lay down general principles, but in each territory there are entomologists and health officers, part of whose duty it is to advise the public on such matters. More detailed information can always be obtained from them.

Personal Protection

Housing

Houses should be sited as far away from breeding-places of Anopheline mosquitoes as possible, preferably on the top of a hill. The distance from their breeding-places at which Anophelines may occur in sufficient numbers to cause an appreciable amount of malaria varies enormously with such factors as the output from the breeding-places and the direction of the prevailing evening breeze; whenever possible houses should be built on sites where the prevailing breeze is from the house towards the breeding-places and not vice versa. If there is no marked prevailing wind, a distance of half a mile between house and breeding-places is sufficient to give a very considerable (though not complete) degree of protection against Anopheline mosquitoes, but if the output of Anophelines from the breeding areas is great and the prevailing evening breeze favours their flight to houses, a great deal of malaria may be caused at a distance of at least two miles from the breeding areas. It may be taken as a rough guide that the number of Anophelines in a dwelling varies inversely as the square of its distance from the breeding area, and it is obvious that the further away a house can be placed the better.

A point of the first importance in the siting of dwellings is that the houses of Europeans and Indians should be as far away as possible from any large assembly of Africans, particularly in the form of labour lines. This is because a high proportion of Africans possess malaria parasites in their blood and the proportion possessing infective forms of the parasites is especially high in young children.

Mosquito-proofing of houses is an invaluable form of protection, but in some parts of East Africa there is a most unreasonable prejudice against "living in a meat-safe". No such prejudice obtains in other parts of the tropics, and in the Panama Canal Zone the entire white population lives in "meat-safes", in spite of the fact that the Canal Zone is often rightly quoted as an example of excellent anti-malarial work. Not only does mosquito-gauze give protection against mosquitoes, but also against the flies which foul our food and give us dysentery. Furthermore, it is often the only means (together with other methods of personal protection) which can be used without

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completely prohibitive expense. An isolated house, for instance, may be situated near extensive breeding grounds, to deal with which would cost many thousands of pounds; obviously this cannot be done. In rural areas the number of persons affected is very frequently so small that they could not possibly afford to pay for the permanent anti-larval measures which are always the method of choice, and no government would be justified in spending large sums of public money to protect a few individuals. In such cases we have no alternative but to fall back on personal protection, especially the mosquito-proofing of houses with wire gauze.

As in all things, there are right and wrong ways of making a house mosquito-proof. Doors should fit well, leaving no gaps through which mosquitoes can enter, should open outwards, and should be fitted with a self-closing device. Mosquito-gauze over the windows should be so arranged that the window can be opened without disturbing the gauze; a good arrangement is to have the gauze on a fixed frame outside the window, the latter opening inwards on long hinges, so that they will fold back against the wall. By far the best and most economical method, however, when a house has a veranda, is to screen the entire veranda instead of screening individual openings. The specifications of the gauze to be used are of extreme importance, especially as I have seen wire-gauze employed in East Africa which was of so large a mesh as to serve little purpose except to give a false sense of security. The correct type of wire-gauze should have not less than 14 meshes to the inch and be of wire of gauge 30 I.S.W.G.

Protection against Bites

The provision of a more or less cleared zone around a house is probably not of very great value, but it doubtless tends to reduce the harbourage for mosquitoes in the vicinity and thus to reduce the chances of attack by an infected Anopheline.

Mosquito-nets over beds are a precaution which should never be neglected even in a mosquito-proof house, because it is always possible for a mosquito to enter when a door is opened (it is to reduce the likelihood of this that doors should open outwards), and if it happens to be an infected Anopheline it may give malaria to one or more of the inhabitants before being disposed of. Bed-nets should have not less than 25-26 holes to the square inch, and should be woven of 30/S or 40/60 cotton; they should be tucked in under the mattress, not left with the ends hanging loose, and this should be done before dusk. Beds should not be so narrow that a restless sleeper is apt to get his elbow against the net; the narrowness of camp-beds is one of the reasons which cause so many people to "go down with malaria" on return from a safari.

In malarious areas mosquito-boots should always be worn after sunset, except in properly mosquito-proofed houses.

Repellants

Particularly on safari, or for those whose work necessitates their being exposed to the bites of mosquitoes at night, substances which repel mosquitoes may usefully be smeared on exposed surfaces of skin. One efficient repellant is made by dissolving naphthalene in hot vaseline and adding citronella oil; the quantities used will vary with individuals, the guiding principle being to use as strong a solution of naphthalene and citronella oil as is consistent with not burning the skin. A repellant of this type is largely used by the South African troops. Some people may find napthalene irritating to the skin; in this case it should be omitted, since citronella oil by itself is a good repellant and persistence in the use of naphthalene may result in dermatitis.

I do not advocate the use of repellants in ordinary circumstances, when the risk of being infected is not very great, but there are special occasions when they are of great value.

MEASURES AGAINST ADULT MOSQUITOES

Mosquitoes breed too rapidly for any measures we may take against adults to have much effect on their numbers, but we can do a good deal to lessen their prevalence in our dwellings and the consequent risk of contracting malaria.

Sprays

Much can be done to reduce the danger of malaria by spraying with one of the proprietary insecticides, or with a home-made pyrethrum spray, in the evening immediately after closing the mosquito doors. The number of Anophelines killed by this means is not likely to be large, but they will probably include a considerable proportion of infected and infective specimens. It is not always realized that not every Anopheline is infective, since it is first necessary for it to bite an infected person and then to ripen the parasites to the infective stage. Anophelines which are allowed to hang about in a house until they reach the infective stage are obviously the most dangerous.

The home-made spray is made as follows: Soak 1 lb. of pyrethrum in half a gallon of kerosene for one day, then filter the solution (preferably through cottonwool) and run the other half gallon of kerosene through the remains of the pyrethrum in two lots, so as to extract as much of the active principle from the pyrethrum as possible. Squeeze out the remains of the pyrethrum and the cottonwool, to avoid wasting any of the liquid, thoroughly mix the various lots of liquid and add any scent desired (such as citronella oil or oil of wintergreen). It is most important that the kerosene should not have too low a flashpoint, like the types used as fuel for internal combustion engines, because a spray made with these would be so inflammable as to be dangerous to use. The spray should be stored in a cool dark place, preferably in a stoneware jar, and will keep for a considerable time. It is cheapest to make sufficient at a time to last for some months, as there is always some loss in manufacture and this loss is proportionately less if a large quantity is made.

In purely native areas in South Africa, where anti-larval measures would be impossibly costly, spraying of dwellings has been used on a large scale to control malaria, and the results have been most encouraging: "After two years' trial over extensive areas of country where other measures are impossible, it is concluded that malaria can be controlled by hut spraying with a pyrethrum insecticide, provided that it is commenced as soon as adults of *Anopheles gambiae* . . . and *A. funestus* . . . begin to enter dwellings, and that it is applied to every hut over as large an area as possible at least once, and preferably twice, a week. The effect is produced, not by a diminution in the numbers of Anophelines but by a reduction in their rate of infection. This may be very marked. Among Anophelines engorged with human blood during the height of the malarial season it [the rate of infection] was found to be below 0.1 per cent in native areas where the malaria incidence had formerly been high." (*Review of Applied Entomology*, B, 1936, p. 77.)

The Coumarin Theory

Some years ago an eminent engineer put forward a theory that portions of Egypt were free from malaria because clovers and other leguminous crops containing coumarin were grown there. His belief was that infected mosquitoes fed on the flowers and that the malaria parasites were thereby killed and the mosquitoes sterilized. (*Rev. Applied Ent.*, B, 1928, p. 26.) Unfortunately, not being an entomologist or a malariologist, he overlooked a fact which provides a much more probable explanation of the absence of malaria from certain parts of Egypt: that the species of Anophelines which are important vectors of malaria are absent or uncommon in these areas.

It is probable that no entomologist ever put much faith in the theory, but several members of the profession have investigated different aspects of it. Their work has produced the following facts:—

(1) In several of the areas instanced by upholders of the "coumarin theory" in support of their belief malaria is certainly absent, but so are the main vectors of the disease. The absence of the vectors is ample explanation of the absence of malaria without recourse to any unproved assertions about sterilization.

(2) In certain parts of Russia lucerne has been grown for hundreds of years near villages where malaria is prevalent.

(3) Only a minute proportion of the mosquitoes found in lucerne fields (by day or night) are Anophelines, although in this series of observations Anophelines were abundant in nearby houses and cattle-sheds. Most of the Anophelines found in the lucerne fields were males, which do not bite and therefore cannot become infected with malaria.

(4) Neither Anophelines nor other mosquitoes feed to any important extent on either the flowers or any other part of such plants.

(5) Neither mosquitoes nor malaria parasites are affected to an appreciable extent by solutions of coumarin of the order of concentration which it would be possible for the mosquitoes to obtain from plants.

Negative evidence is never conclusive, but this array of facts comes as near to being so as is ever possible. No evidence has ever been produced in favour of the coumarin theory which is not capable of a much simpler explanation, and it seems certain that the theory was based on incomplete observation of the facts.

Quinine Prophylaxis and Bonification

Quinine prophylaxis is not an entomological subject, and I do not propose to deal with it in its general aspects. But an extension of the method, in the form of mass-treatment of the population with quinine or plasmoquine, with a view to depriving Anophelines of the oppor-

tunity to acquire malaria parasites, does trench on the entomological side of the malaria problem, and this must have a brief mention. The theory behind this idea is unquestionably sound: man is the only known reservoir of the parasites of human malaria, and if we could destroy these parasites in the whole population it is clear that malaria would cease to exist, just as surely as it would if every Anopheline mosquito could be destroyed. But the practical value of the method is doubtful; the cost would be very great, and the presence of a very few overlooked or insufficiently treated cases would be sufficient to vitiate the entire result.

Bonification is another non-entomological side of the subject of malaria control into which I am not competent to go deeply. The theory is that by raising the standard of living among a population (particularly in respect to housing and diet) it is possible to reduce the amount of ill-health due to malaria. Whatever value this method may have in the case of the African, who is usually very badly housed and often lives on a very unsatisfactory diet, it obviously has little if any application to the average European, who is already well-fed and well-housed.

Akin to the question of personal immunity is the often-made claim that certain districts are "free from malaria". Although there probably are parts of East Africa where the disease does not exist, I would urge readers to be exceedingly cautious about accepting this claim as true; it is often completely baseless. The claim used to be made for a certain mission station in Uganda, where the European staff claimed that they never suffered from malaria. Investigation showed that malaria-infected Anophelines were not uncommon in the station and that the staff suffered from frequent attacks of a disease which they chose to call influenza and which they cured with quinine.

Naturalistic Measures against Larvæ

Before discussing measures to be taken against Anopheline larvæ, it is important to know in what type of breeding places they do or do not occur, remembering that by no means every species of Anopheline is a vector of malaria. The species which carry malaria do not occur in the sort of breeding places (old tins, bottles and the like) which are of so much importance in work directed against yellow fever, nor do they breed in every pool, ditch or swamp, but only in those in which conditions are suitable. Not only is it possible to waste a great deal of money in attempting to control breeding places which are not a source of dangerous Anophelines, but it is very easy to convert a source of relatively harmless mosquitoes into a source of dangerous vectors of malaria. Nor is experience of malaria control in other parts of the world of much use as a guide to the proper procedure in East Africa until it has been supplemented by a considerable amount of knowledge of local conditions. In Malaya, for instance, one of the principal vectors of malaria breeds in marshy forests, and an unwary malariologist whose experience lay solely in Malaya might well attempt to control malaria in East Africa by clearing such forests. By so doing he would probably convert breeding places of two unimportant species of Anophelines, neither of which is a vector of malaria, into sources of our two most dangerous vectors. Even in different parts of Africa the same principle holds good to some extent; the breeding places of *A. funestus*, one of our principal vectors, vary to some extent in different parts of Africa, and experts from South Africa have been known to refuse to believe that *funestus* would breed in certain types of waters in which it is common in Uganda, until convinced by the evidence of their own eyes. My own experience has been mainly in Uganda, and it is quite possible that some statements I may make may not apply to other parts of East Africa.

Naturalistic methods of control of mosquitoes are those methods directed towards making water unsuitable for dangerous malaria-vectors without abolishing the water or using such substances as oil or paris green. Obviously, the dividing line between regular application of a substance like paris green and a method like letting the sea in to a coastal marsh to render the water too salty for the local malaria-vector is exceedingly fine. I have chosen to regard as naturalistic all measures which do not involve the entire abolition of the water or the application of chemical substances at frequent intervals.

Naturalistic methods of mosquito control are based on the fact that Anophelines are usually rather strictly limited in their choice of breeding waters by such factors as light and shade, temperature, the presence of suspended mud, salt, or other inorganic substances in solution, dissolved organic matter, an adequate food supply, and the presence or absence of natural enemies, and on the further fact that in most areas only one or two species of Anophelines are really important vectors of malaria. In most parts of East Africa the only important

vectors are *Anopheles gambiae* and *A. funestus*, so that if we can succeed in rendering waters unsuitable for these two species we have practically solved the problem of malaria. Unfortunately, these two species have widely differing requirements in breeding waters, so that a very wide range of water conditions is suitable for one or the other of them; it is obviously of very little use making a pool unsuitable for *gambiae* if we thereby made it more suitable for *funestus* than it was before. Careful study of the requirements of the main vectors of malaria in a given district is necessary before naturalistic measures can be applied with success, but most of the suggestions made below are applicable in any area of East Africa in which *gambiae* and *funestus* are the important vectors.

Organic Pollution of Water

It is a well-known fact in many parts of the world that waters heavily polluted by decaying organic matter are often unsuitable either for Anophelines in general or for the local vectors of malaria. In East Africa, for instance, sisal waste and coffee hullings permitted to run into a stream will render the stream unsuitable for both *Anopheles gambiae* and *A. funestus* for a considerable distance below the source of pollution.

This fact has been turned to account in devising a very efficient and exceptionally cheap method of prevention of malaria. If green vegetation be cut and thrown into a pool which is breeding Anophelines, the vegetation rapidly decays and breeding of *gambiae* and *funestus* is entirely inhibited. In an experiment performed in Kampala in 1932 four clay pits, all breeding *gambiae* and *funestus*, were selected and bundles of green elephant grass were thrown into two of them in quantity just sufficient to cover the entire surface of the water, the other two being left untreated as controls. The pits were examined at intervals of three days. Both the control pits continued to produce large numbers of anophelines throughout the experiment, whereas of the treated pits one had already ceased to produce Anophelines three days after treatment and the other at the second search (three days later). After four months, during which no more grass was added to the pits, an unfortunate misunderstanding caused the control pits to be oiled and more grass to be added to the treated pits, and the experiment had to be abandoned. It had, however, shown that complete control of Anophelines can be attained by this means in a few days and may persist for at least four months; as the effect of the treatment showed no signs of diminishing towards the end of the period, four months is probably far below the maximum duration of effective control. It is essential that the vegetation be green; dry vegetation would produce a different result and would probably be entirely ineffective.

The serious defect of the method is that, although it inhibits the breeding of Anophelines, it in no way prevents the breeding of certain Culicines, including some which frequent houses and bite man. As, however, these Culicines are not known to include any important vectors of disease, the method remains of great value, especially in rural areas where expensive measures would be financially impossible. Certain of our East African Anophelines can tolerate a much higher degree of organic pollution of their breeding water than can *gambiae* and *funestus*, but (as far as I am aware) none of these are important vectors of malaria.

A modification of the method has been used for small streams in Malaya, but apparently met with inadequate success.

Salt

Since the number of species of Anophelines which can tolerate a marked degree of saltiness or brackishness of the breeding water is very limited, malariologists in various parts of the world have advocated such measures as cutting channels to connect coastal marshes with the sea and thus increase the salt content of the water of the marshes. As both *Anopheles gambiae* and *A. funestus* can tolerate a marked degree of salt in the water (the latter, for instance, breeding in the brackish pools surrounding Lake Magadi), the method is not likely to be of any practical value in East Africa. In any case, it should never be employed without a thorough knowledge of local conditions.

Suspended Mud

Muddy waters inhibit the breeding of a large number of species of Anophelines, and in certain parts of the world practical use has been made of this fact by employing methods designed to keep the water constantly muddy. *Anopheles gambiae*, however, not only tolerates muddy water but actually seems to prefer it, so the method would be completely useless in any area where this species is an important vector, as it is over the greater part of East Africa.

Natural Enemies

Although mosquito larvæ in their natural habitat have enormous numbers of enemies, no means has yet been discovered by which we can encourage these enemies, and thus cause them to make a practical contribution to mosquito control, except in the case of fish. As to the value of fish in mosquito control, there has been much difference of opinion in the past, but this seems to have been due almost entirely to misconception of what may reasonably be expected of fish in the matter. The settler who wishes to keep his dam-pond covered with water lilies and other aquatic plants, and hopes to prevent the breeding of mosquitoes by introducing a few fish, is asking the impossible. But there is no doubt whatever that, in suitable conditions, fish can provide efficient and extremely cheap assistance in controlling mosquitoes.

The essentials for efficient mosquito control by means of fish are the selection of a suitable species of fish and the provision of conditions in which they can readily observe and seize their prey.

A great many East African fish include mosquito larvæ in their diet, and some of them are quite efficient mosquito destroyers, but it is doubtful if any of them fulfil the specifications for the ideal larvivorous fish as well as do the imported "top-minnows" or millions", *Gambusia* and *Lebistes*. To be really efficient in mosquito control a fish must be a surface feeder (since Anopheline larvæ spend most of their time at the surface) and must prefer mosquito larvæ as an article of diet; it must be small, not only to enable it to follow the mosquito larvæ into shallow water but also so that it shall not itself be regarded as a worthwhile article of diet by man and be exterminated in consequence; it must be highly prolific to enable it to withstand the attacks of kingfishers and other enemies (in Kampala, dragonfly larvæ have proved a very serious check on the multiplication of these small fish); and it should be able to accommodate itself to considerable changes in the temperature and constitution of the water. Both *Gambusia* and *Lebistes* fulfil these conditions well, but in Kampala the rate of multiplication of the former is somewhat too slow to enable it to withstand very successfully the attacks of predatory enemies, and *Lebistes* has been much more successful; it is quite probable that in somewhat cooler conditions the advantage might be reversed and might lie with *Gambusia*.

In muddy water the fish are unable to see their prey and (although many mosquito larvæ may be eaten) many will escape. In weed-grown water, not only can the larvæ hide among the weed, but if the weed cover be dense the fish may be unable to penetrate it. If therefore it is desired to control mosquito breeding in a weed-grown pool by means of fish, it is first necessary that at least as much of the water plants be cleared away as will give the fish easy access to all parts of the pool.

As already mentioned, it is improbable that indigenous fish can be made much use of in mosquito control. But in special circumstances they can be quite valuable. At Jinja I found two pools close to the lake edge which apparently differed only in that one was open to the lake whereas the other was cut off from the lake by a miniature sandbar. The former was constantly visited by small indigenous fish and contained very few larvæ, whereas the latter contained no fish and very numerous larvæ. Cutting the sandbar gave the fish access to the second pool and greatly reduced the amount of successful mosquito breeding in it.

An interesting possibility which has been successfully used elsewhere but, so far as I am aware, has not been tried in East Africa, is to combine the introduction of *Gambusia* or *Lebistes* with that of a purely herbivorous fish. The latter keeps down the growth of weed and thus enables the larvivorous fish to do their work without further interference by man. As, however, suitable herbivorous fish are usually edible and fairly large, this method can hardly be used except in places where it is possible to prevent excessive fishing.

Among natural enemies of mosquito larvæ a brief mention must be made of the various species of plants (mainly *Lemna, Azolla* and *Salvinia*) which sometimes form so dense a carpet over the water surface that breeding of mosquitoes is inhibited. Although *Lemna* and *Azolla* occur in Uganda, I have not found them to form a sufficiently complete carpet. At least, for the present they must be dismissed from practical consideration.

Wave Action

Most mosquitoes are unable to breed successfully in water which is in constant agitation. In a fast flowing stream, for instance, it is normal to find that the larvæ are rather strictly confined to backwaters, the lee of sandbanks, patches of weed and similar places

where the flow is obstructed. Similarly, in a lake the larvæ are not found in the open water (where wind creates strong wave action) nor in lengths of shore-line where waves beat freely on the beach, but may occur in numbers in the shallows if wave action is obstructed by mudbanks or belts of reeds.

The application of this principle provides one of our most important naturalistic methods of mosquito control. In streams removal of all obstructions to the flow reduces breeding to a minimum.

The principle has been applied to mosquitoes breeding in the edges of Lake Victoria at Jinja, where control operations were on a large scale. For miles along the edge of the lake there was a belt of papyrus, margined on the outer side by a zone of floating vegetation and debris and on the inner side by a belt of shallow water or soft waterlogged ground in which hoofprints of cattle and hippos produced ideal breeding places for both *Anopheles gambiae* and *A. funestus*. There was little breeding of important species of mosquitoes in the papyrus belt, but breeding was extensive both in the lakeward zone of floating debris and in the shoreward zone of shallow water and waterlogged ground.

The method adopted was a combination of dredging and filling; no dredger was available so the work had to be done entirely by hand. The papyrus and mudbanks were cut away and much of the material thus obtained was used to raise the bank to well above lake level; portions of the outer part of the bank itself were also cut away and used to raise the level of the parts further back. Papyrus not required for filling was allowed to float away over the Ripon Falls and down the Nile. The final result was a nearly straight shore-line formed by firm steep banks raised well above lake level and fully exposed to wave action; at first the banks were faced with uncut stones, but later this was not considered essential. An unusual complication was that throughout the work it was necessary to station an African guard with a rifle to protect the labourers from crocodiles; a good deal of ammunition was expended in warding off such attacks, but there were no casualties among the labour (nor, so far as I am aware, among the crocodiles).

It cannot be claimed that the method was cheap, but the results were excellent. Although the work was begun in 1931, so that portions of it are ten years old, expenditure on upkeep has been negligible, and breeding of Anophelines along the whole completed stretch of coast has been almost entirely eliminated. Before this work was carried out control along this stretch of coast was attempted by means of paris green and oil, which was expensive as well as not being efficient in the peculiar circumstances. The saving effected by elimination of the need to use these larvicides will eventually pay for the work, but I am unable to give figures of the cost of reclamation because most of the labourers were convicts. It is essential to keep the banks clear of vegetation or breeding will recur.

The same method has recently been applied with complete success to a small lake in Kampala, in which extensive breeding of *Anopheles funestus* occurred in the weedy shallows round the margins. Dredging out of these shallows and utilizing the material to form a steep and firm bank has, for all practical purposes, eliminated this species from the lake.

Malariologists in Asia have employed a similar principle against stream-breeding Anophelines, the water being impounded by a dam and the sluices opened once a week. The water flows out with a rush, many mosquito larvæ are stranded and others are drowned. The method is undoubtedly of value in some circumstances, but it is doubtful if it would have much application in East Africa, where stream breeding is normally of secondary importance and where erosion has to be taken into very serious consideration.

In all instances where swamps or marshy land have to be dealt with, by any method, a first essential is to keep cattle out of the area. Their hoofprints are prolific sources of malaria-carrying mosquitoes, and where wave action is to be utilized they do much damage by breaking down the banks.

Shading

In certain parts of Asia the most important malaria-vector breeds only in well-shaded water, so that removal of the shade is an effective method of control. The method would be valueless in East Africa, where *A. gambiae* prefers unshaded water and *A. funestus* can tolerate it. Intensification of the shade is, however, an efficient method of inhibiting the breeding of both these species if the shade is made sufficiently dense.

The simplest application of the principle is, of course, to refrain from felling natural

forest. In Uganda, streams and pools in dense forests breed considerable numbers of Anophelines of two species, but neither of the species is domestic, and neither is likely to be a vector of malaria. The use of afforestation for control of mosquito breeding in swamps has eventuated partly from this observation, but this method employs more than one principle and will be considered under a separate heading.

Another very simple use of shade is to erect thatch roofs over native waterholes, the roof being of just sufficient height to allow of convenient use of the waterhole and of sufficient size to shade the entire water surface throughout the day. In such waterholes the use of larvicides such are oil or paris green would be highly undesirable, but shading effectively prevents the breeding of malaria-vectors and is popular, because the thatch roof keeps the water cool.

Afforestation

Swamps are among the more difficult problems met with in malaria control in East Africa, mainly because of the enormous size of many of them. In permanent swamps, breeding of malaria-vectors is very largely confined to the sides, while in wet-weather swamps the whole area may become a prolific breeding ground of vector Anophelines during the rains. Lake-shore swamps are a separate problem and have been discussed under the heading "Wave Action". Because (owing to organic pollution of the water in the heart of a permanent swamp) the edges of such swamps are much more dangerous than the centre, it is very easy, by unsuitable efforts at drainage, to create conditions which are worse than those which it was sought to remedy. For ditches are themselves important breeding places of malaria-vectors and the opening-up of a swamp may render the water in the swamp ditches sufficiently free of organic pollution to permit of breeding.

I have dealt with the question of swamp afforestation in a recent article in the *East African Medical Journal* (August, 1940), and it is unnecessary to repeat here all that I wrote there. But it is important to recognize what is claimed for afforestation as a method of dealing with swamps, a few sometimes overlooked essentials in the use of the method, and one serious but very temporary danger.

The use of afforestation in malaria control is based partly on the drying effect produced by the trees and partly on shading. The advantages which I claim for it over simple drainage of swamps are that it dries up the swamp much more rapidly, that the proportion of drainage ditches which soon become dry is greatly increased, that if the planting of trees along the residual ditches is so done that the ditches are very heavily shaded they will cease to breed vectors of malaria, and that it pays for itself and may even show a profit.

In afforesting a swamp the first essential is to select a species of tree which will grow well in very wet conditions. Eucalyptus is normally used, and the species found most generally suitable in Uganda swamps is *E. robusta*. Even this species can rarely be expected to establish itself in a permanent swamp without some drainage, and in a swamp of fair size a few main channels will certainly be necessary; it will also usually be necessary to plant the young trees on mounds of mud, so as to bring them above the surface of the water. Along such ditches as are likely to be permanent, our aim must be to produce shade which is so heavy as to inhibit the breeding of malaria vectors, and for this purpose eucalyptus is unsuitable because it does not produce a heavy shade. Mango is moderately suitable for this purpose, but it is likely that indigenous species of *Ficus* would be much better; some of them are quick growing and can be propagated from quite large branches, especially if "layering" is employed. *Tithonia diversifolia*, a shrub known as Mexican Marigold, has been used extensively in Java to shade ditches and narrow streams, and I believe that it has also been successfully employed for this purpose in Tanganyika. It grows rapidly and forms very dense shade, so it should be excellent for the purpose.

A great, though quite temporary, drawback of the method is that the ring-shaped trenches from which the mud to build the mounds is obtained are apt to become exceptionally prolific breeding places of *A. gambiae* until growth of the trees and drying up of the swamp render them harmless. It is absolutely essential that this should be prevented. By far the simplest and cheapest method of dealing with them is to fill them with cut green vegetation as described under "Organic Pollution". An alternative is to treat them with paris green, but this has no advantage over the use of decaying vegetation, as it does not affect the breeding of Culicines. Oil must not be used, as it would kill the young trees.

(*To be continued*)

A NOTE ON GROUNDNUT SELECTION WORK

By Norman Humphrey, Senior Agricultural Officer, Kenya

In a previous article (*East African Agricultural Journal*, September, 1939), written at the end of 1938, a description was given of work that had been done at the Coast Experiment Station, Kibarani, with the object of raising strains of groundnuts resistant to a wilt disease that had effectively prevented this crop from being grown to any extent in coastal Kenya.

From the results obtained it was concluded that if resistance to wilt were maintained in 1939 it would be possible to contemplate introducing groundnuts as an economic crop for the coast. It was also pointed out that in 1938 poor germination had replaced wilt as the most serious limiting factor, and it was stated that more information on this aspect was being sought. The results of the work of the last three years are the subject of this note.

The percentage of wilted plants in progeny rows for the last four seasons, 1937–1940, has been 25.5, 9.5, 6.1, 7.9 respectively. It will be seen that the degree of resistance obtained by 1938 has been maintained. In view of these results, the crop is now being introduced into cultivation, and already yields of over 1,000 lb. per acre of unshelled nuts have been obtained by growers.

Factors Affecting Yield

During the early years of selection work, wilt resistance was the essential consideration. At that time, too, the Station was still young and equipment was not adequate for a careful study of other factors affecting yield. Accordingly, the only additional method of selection that presented itself was based on the number of nuts per plant, an arbitrary figure being chosen as a standard each season and plants bearing less than that number being discarded.

By the end of 1938, however, it was possible to consider whether this method was entirely satisfactory, and the need for better germination made such consideration a matter of urgency.

The chief factors affecting yield were wilt, germination, number of nuts per plant, and the weight of nut. In view of the rapidity with which the seed loses its viability on shelling, weight of nut is for the present purpose the weight of unshelled nut. Whilst one would expect high nut weight to be correlated with subsequent good germination, it was desirable to ascertain definitely what effects, if any, these various factors have on one another.

No correlation has been found to exist between wilt and percentage stand, nor was any significant correlation found between percentage stand and number of nuts per plant. It is not surprising, therefore, that no improvement in germination had been observed during the previous years. It seemed evident that some attention should be paid to nut weight.

Number of Nuts per Plant and Nut Weight

Considering that selection based on number of nuts per plant had been carried out regularly, one would have expected, if this were a strong hereditary character, to find that the new strains were showing a definite improvement in the number of nuts borne. In fact, however, any such improvement, if it exists, is so slight as to be masked by seasonal fluctuations. Whilst therefore one would obviously not choose plants bearing only a few nuts, the importance of this factor diminishes considerably from the selection point of view. Studies of correlations between the number of nuts per plant and nut weight showed that, when the number of nuts is less than about 100, no correlation exists; if the number of nuts rises above that figure, then a negative correlation is found. In other words, by selecting plants bearing only a very high number of nuts, one would be likely to obtain a slight reduction in nut weight. These results confirmed the view that greater attention must be paid to the latter factor.

Nut Weight and Germination

In view of the foregoing, due consideration was paid to nut weight when making the final selections for planting in 1939 and in subsequent seasons. During this period a series of correlations between percentage stand and nut weight have been tested with results that can be summarized as follows:—

(1) The percentage stand after germination gave a significant positive correlation with average nut weight at harvest in 1938 and 1939. In 1940 the correlation was still positive but was not significant.

(2) The average nut weight at harvest in 1938 gave a significant positive correlation with percentage stand in 1939. In the two following seasons the correlation was positive but not significant.

TABLE I
PERCENTAGE GROUND-NUT STANDS, 1938–41

YEAR	PERCENTAGE STAND	
	Progeny Rows	Bulks
	Per cent	*Per cent*
1938	58·8	40·1
1939	77·3	70·8
1940	74·5	75·5
1941	88·5	77·9
MEAN ..	74·8	66·1

The results are interesting, as they suggest that nut weight is an hereditary character. The fact that, as selection proceeded, the correlations ceased to be significant might be expected if, as a result of this selection, germination had improved markedly. Such had been the case. Progeny rows have shown very marked improvement, and a similar effect is also seen in the bulks. One would expect these bulks, which gradually improve by discarding of earlier selections and replacement by good progeny rows, to follow the latter in a general upward climb. This also has been the case, as shown in Table I.

These figures indicate that, after allowing for seasonal variations, a very definite improvement in germination has been obtained. This, in conjunction with continued wilt resistance, may be considered a matter for satisfaction.

Summary

(1) Wilt resistance has continued at a level high enough to render the crop an economic one for natives.

(2) The method of selection on an arbitrary number of nuts per plant has been found to be unsatisfactory.

(3) A close connexion between germination and nut weight has been found, which has permitted a considerable improvement in germination by taking nut weight into account when individual plant selections have been made.

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PHENOTHIAZINE IN THE TREATMENT OF STRONGYLOSIS IN HORSES

By J. Carmichael, Veterinary Laboratory, Entebbe

Strongylosis, or "Redworm infection", is without doubt one of the major causes of unthriftiness in horses in East Africa, and a note on the results of treatment with phenothiazine as experienced at Entebbe may be useful.

We have experimented with "Allegan," a Bayer product, and the more orthodox oil of chenopodium in linseed oil, and we find that phenothiazine is more efficient as a vermicide and preferable as a method of medication. Oil of chenopodium treatment requires preliminary preparation and starvation, and in addition produces marked nausea and tends to debilitate the animal. "Allegan" is excellent in many ways, but is expensive. Neither of these drugs is as efficient as phenothiazine when their vermicidal properties are assessed by comparative fæcal egg counts in which the number of strongyle eggs per gramme of fæces is estimated by standard methods before and after treatment.

Phenothiazine is a greenish-brown powder with a characteristic smell. There is no need to starve the horse, and the dose is given in a bran mash in the evening. If the whole of the feed is not finished the remains can be mixed with the usual morning feed. In the cases treated here we have had no trouble about the horse taking it, but of course individuals may differ. In our cases the number of strongyle eggs in the fæces was reduced from several hundreds, and in one case over a thousand, per gramme to nil within two days.

According to reports from England, phenothiazine is very non-toxic and many times the medicinal dose has been given experimentally without causing marked ill-effects. In America, where it is in very general use, there have been a few cases of poisoning reported. It is difficult to say whether these were due to a faulty sample of phenothiazine or a special susceptibility of the horses treated. There was, however, one common factor—the horses were getting molasses in their feed. It is therefore recommended, to be on the safe side, that molasses should not be fed for twelve hours before and forty-eight hours after phenothiazine treatment.

The dose is 35 grammes for horses, 30 grammes for polo-pony type, and 20 to 25 grammes for yearlings, given in a bran mash with a handful of crushed oats, and, as mentioned before, no starving or special preparation is necessary. It is recommended that phenothiazine be given only on veterinary advice; indiscrimiate use of the drug has led to a number of regrettable accidents, especially in America.[1]

[1] Also in Australia. *Agr. J. N.S.W.* for December, 1941, contains a similar warning.—*Ed.*

ARSENICAL POISONING OF STOCK, WITH PARTICULAR REFERENCE TO CATTLE

Compiled by the Veterinary Department, Kabete, Kenya

The annual loss sustained by the farming community through the arsenical poisoning of live stock is considerable. In territories where arsenical dipping fluids are extensively used to control tick infestation and where, unfortunately, invasions of locusts render it necessary at times to spread arsenical baits to control hoppers, some mortality from this cause is to be expected. Actually, however, where proper precautions are taken, the number of deaths due to animals drinking dipping fluid while in the dip is negligible, and only occasional reports of poisoning due to animals picking up locust bait on pasture are received. Perusal of the reports on specimens sent to the Veterinary Laboratory, Kabete, for chemical examination show that the vast majority of cases of arsenical poisoning are attributable to carelessness. The supervision of dipping operations should be entrusted to someone of greater responsibility than a casual labourer, and sodium arsenite and dip concentrates should be kept in a reasonably permanent type of building, the door of which should never be unlocked except in the presence of a European.

Symptoms.—In peracute cases the animal collapses and dies in convulsions within an hour or two of the ingestion of the poison.

Acute cases are the commonest. Several hours after the poison has been taken, general uneasiness is observed and this is quickly followed by profuse salivation, inappetence, restlessness and signs of abdominal pain. Pain increases, there is grinding of the teeth and diarrhoea, the fluid fæces being often black in colour. Muscular tremors and weakness of the hind limbs are observed, the extremities are cold, the pulse is weak, and the respirations are accelerated. Death occurs in convulsions in one or two days.

Subacute and chronic forms occur when a single small dose or repeated small doses are taken. Symptoms may not appear for a day or two, and then develop gradually. The first signs of sickness are uneasiness and a vague discomfort. Later, food is refused and the animal starts to salivate and grind its teeth. Condition is lost, the abdomen is "tucked up", and profuse diarrhoea accompanied by muscular tremors and weakness of the hind limbs begins. Finally, some days after the animal has first been noticed to be sick, it is unable to rise, the temperature becomes subnormal and death supervenes.

Post-mortem Lesions.—These vary somewhat in severity and location according to the form in which the arsenic is ingested and the amount taken. Thus in peracute cases obvious lesions may be confined to one of the four stomachs, although usually the small intestines are also involved.

The most characteristic lesion of arsenical poisoning in ruminants is a diffuse rosy-red coloration of the fourth stomach. This is not a constant lesion, but when present should always lead to the suspicion that arsenic was responsible for death. In some cases the lesion may be more intense and more localized. For example, in a sheep that died after picking up locust bait, the only lesion found was an intensely hæmorrhagic patch, about the size of the palm of the hand, in the first stomach. The surface layers in the centre of this patch appeared white and corroded. Similar restricted lesions have been observed in the fourth stomach of cattle.

In acute and subacute cases, inflammation, varying in intensity in different areas, may be found throughout the whole length of the alimentary canal. The pharynx and larynx may be purplish-red in colour, the mucosa of the rumen inflamed and easily peeled. The fourth stomach may show definite hæmorrhages in addition to its diffuse rosy-red general coloration and there is usually marked inflammation in the small intestine and cæcum. The latter organ sometimes shows alternate black and red patches on its mucous membrane and the rectum is frequently congested.

Lesions outside the alimentary tract are even more subject to variation than those within. The heart usually shows hæmorrhages, both inside and out. These may be only small petechiæ, but in some cases large black patches are noticed. In the more acute cases the liver is enlarged and congested in appearance; in the less acute cases it is pale and fatty. The kidneys often show small hæmorrhages in the cortex and congestion in the boundary zone between the cortex and medulla.

Diagnosis.—When the history of the case is insufficient to enable a definite diagnosis to be made, it may be necessary to resort to the chemical examination of various organs. If

the post-mortem examination suggests arsenical poisoning, the management of the cattle and of any stocks of arsenic on the farm should be investigated closely. Stockowners may be most emphatic in stating that their animals cannot possibly have had access to arsenic in any form, but will recall later the existence of some forgotten dump or old drum still containing a little arsenic. An interesting case occurred not long ago when the owner of some stock which had died from arsenical poisoning was quite certain that they could not have obtained arsenic. Persistent inquiry elicited the information that a store, which had contained arsenic, had recently been swept out through the door. Analysis of the dust near the door revealed that it contained 25 per cent of sodium arsenite. A not uncommon source of arsenical poisoning is defective draining pens at the cattle dip, and animals may also pick up poisonous doses of arsenic when they are allowed to graze an area where the vegetation has been repeatedly splashed with dip as the animals plunge in.

The chemical test used at Kabete for the detection of arsenic in specimens is very delicate, the smallest traces being demonstrable. The best organs to send for analyses are the whole or portions of the stomach (the fourth stomach in cattle and sheep), a piece of small intestine, and a piece of liver and kidney. They should be sent preferably with some formalin added as a preservative. Even if an animal has been dead for some time and the carcass has decomposed, chemical examination will enable a definite diagnosis to be given.

The statement is often made that the organs of animals that have died of arsenical poisoning do not decompose with their usual rapidity after death. This statement is often correct in the case of small animals. In cattle, however, delay in decomposition is rarely noticeable, except perhaps occasionally in the fourth stomach.

Treatment of Arsenical Poisoning in Cattle.—The classical treatment for arsenical poisoning consists in the administration of large doses of freshly precipitated ferric hydroxide prepared by the addition of an alkali to a solution of ferric chloride. Recently, considerable doubt has been thrown on the value of this treatment, and an alternative treatment has been introduced to South African farmers by Dr. Steyn, of Onderstepoort. In this treatment sodium thiosulphate, known to photographers as "Hypo", is given either by the mouth or, to obtain more rapid action, intravenously.

In order to obtain information as to the comparative values of the new and old methods of treatment, a series of experiments was planned at Kabete. Young healthy cattle were given a dose of arsenic sufficient to cause death and the interval between the administration of the poison and the commencement of treatment was varied from a few minutes to twenty-four hours.

In the first experiment the two antidotes were given to different animals twenty-four hours after the arsenic. Both died in about the same time as the untreated control animals. In later experiments it was shown that neither treatment was successful unless the time lag had been greatly reduced. It was then found that animals could be cured by administration of sodium thiosulphate intravenously and by the mouth when the antidote was administered within a few hours of the poisoning. The ferric hydroxide treatment proved effective only when given immediately after the lethal dose of arsenic. In this series of experiments the dose of arsenic had been adjusted so that death occurred in about three days. No doubt, if still smaller doses had been given, the treatments would have proved effective when the interval before administration was somewhat more prolonged. The superiority of sodium thiosulphate as an antidote was, however, clearly demonstrated and the importance of early administration of the antidote was equally well proven.

The following is the method of administration of sodium thiosulphate. When possible the intravenous inoculations should be given in addition to treatment by the mouth.

(1) According to the size of the animal, give ¼ to 1 oz. of sodium thiosulphate in half a pint of water as a drench. The dose may be repeated in 15 to 20 minutes.

(2) Similarly 2 to 10 grammes of sodium thiosulphate should be dissolved in 10 to 50 c.c. of boiling water and, after cooling to body temperature by immersing the bottle in cold water, the solution should be injected slowly into the jugular vein. The injection may with advantage be repeated once or twice; for example, the same evening and again the next morning.

In addition to specific treatment, symptomatic treatment is of considerable value. About an hour after the administration of the antidote a purgative dose of raw linseed oil (half to one and a half pints) should be given. This should be followed by demulcent drinks, milk or lime water, and in the case of valuable

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WILD RUBBER IN EAST AFRICA

By P. J. Greenway, Systematic Botanist, East African Agricultural Research Station, Amani

There are quite a number of families in the vegetable kingdom whose plants contain latex which frequently is white but in some species is coloured. However good the flow of latex from a plant, it does not imply that it contains the substance caoutchouc, which is the chief constituent of rubber.

The export of rubber from East Africa reached its peak about 1910; since then it has steadily declined. Customs reports and trade returns did not fully distinguish between wild and plantation rubber till 1912, but it appears that at the peak, Uganda and Kenya each supplied about 100,000 lb. of wild rubber, Tanganyika 300,000, Zanzibar over 4,000, and Nyasaland nearly 60,000. In 1938, no wild rubber is recorded except from Kenya, 6,900 lb., and Tanganyika, 18,700 lb. In 1939 these figures had dropped to 4,200 and 6,200 lb. respectively.

The main sources of East African wild rubber are members of the Apocynaceae (to which the Frangipani and Oleander belong). The most important of them are *Clitandra orientalis* K. Schum., *Funtumia elastica* (Preuss) Stapf, *Landolphia* spp. and *Mascarenhasia elastica* K. Schum.

Clitandra orientalis

A climbing shrub with shortly stalked, opposite, oblong or oblanceolate, slightly wavy margined, leathery leaves, somewhat glossy above; small dense axillary and terminal panicles of small white sweetly scented tubular flowers; fruits rounded oblong, about 2½ by 1¼ inches, orange when ripe, with the seeds embedded in a red pulp. Originally discovered at Bukoba, and was common in many forests around the shores of Lake Victoria.

There is no definite information as to the method of obtaining the latex. The rubber is said to be dark in colour and of good quality. An Imperial Institute analysis of sheet rubber (dry washed) gives 84.8 per cent caoutchouc, 6.4 per cent resin, 8.5 per cent protein, and 0.3 per cent ash.

Funtumia elastica (*also known as Kickxia elastica* Preuss.)

Lagos Silk-rubber Tree; African Rubber Tree, is an evergreen tree up to 100 ft. tall, with an erect cylindrical trunk with opposite, oblong or lanceolate-oblong, acuminate, undulate margined leaves, 4 to 10 in. long, 1½ to 4 in. broad; dense many-flowered axillary cymes of yellow-white sweetly scented tubular flowers; fruits woody, in pairs at right angles to each other on a common stalk, each up to 6 in. long filled with a white floss which is attached in tufts to flattish-oblong up to ¾ in. long seeds. A West African forest tree, which extends into Uganda, where it was first recorded in 1903. In the following few years a considerable area was planted on some estates, but was abandoned as it was unprofitable when in competition with para rubber. The latex is obtained from the stems by tapping, a rather narrow-angled wide-spaced herringbone pattern being used, or long vertical cuts up to 60 feet. The yield of latex, ranges from 2¼ to 20 fluid oz. from a tree, giving about ¼ to 6 oz of dry rubber per annum. In West Africa a large tree gave the exceptional yield of 80 fluid oz. of latex, yielding about 2 lb. of rubber, but it is known that yields from cultivated trees were much smaller, due probably to their youth. The latex can be coagulated spontaneously, by creaming, by boiling, or by tannic acid, mercuric chloride or formalin. The rubber was prepared by machinery in the form of crêpe or sheet. There are numerous analytical figures, and the Imperial Institute found that Uganda biscuit rubber (dry washed) contained 86.1 per cent caoutchouc, 6.5 per cent resin, 6.6 per cent protein, and 0.8 per cent ash. Uganda sheet rubber (dry washed) had 90.3 per cent caoutchouc, 7.7 per cent resin, 1.7 per cent protein, and 0.3 per cent ash.

Landolphia

These are hairy or glabrous shrubs, often of large size, usually climbing by branched terminal or false-axillary tendrils (modified flowering branches) or by sensitive flowering branches; rarely dwarf shrubs or undershrubs with partly herbaceous branches; their leaves are opposite, of varying size; flowers usually white, tubular, sweetly scented, rarely up to 2 in. long in bud, sessile or stalked in few- or many-flowered corymbs or panicles which are sensitive and often act as hooks or tendrils; fruit a globular or pear-shaped berry, sometimes of large size; seeds few to many embedded in a juicy pulp. The fruits of some species are edible.

L. Daweii Stapf.—A glabrous climbing shrub; leaves oblong 4 to 8 in. long by 1¼ to 2¼ in. broad; flowers in dense, very short-stalked corymbs at the ends of the branches and from the axils of the uppermost leaf pairs, the terminal up to 12-flowered, flowers about ½ in. long. Originally collected by Dawe in forest at Dumu in Uganda, and apparently restricted to Uganda. Dawe stated that the vines when carefully tapped will give much more than 8 oz. of dry rubber per annum, and a large vine will give as much as 40 fluid oz. of latex at one tapping. The natives say vines can be tapped three times a year without injury. There is no information as to methods of coagulation. The Imperial Institute found that sheet rubber (dry washed) contained 92.4 per cent caoutchouc, 6.6 per cent resin, 0.8 per cent protein, and 0.2 per cent ash; biscuit, 91.1 per cent caoutchouc, 7.7 per cent resin, 0.9 per cent protein, and 0.3 per cent ash.

L. kilimandjarica (Warb.) Stapf (Laitokitok Rubber).—A climbing glabrous shrub; leaves oblong to broadly lanceolate, 2 to 4 in. long by 1 to 1½ in. broad, thinly leathery or papery and glossy above; flowers in terminal short racemes or small panicles, stalked, about ½ in. long in bud; fruit globose up to 2 in. in diameter mottled with yellow and dotted with minute raised warts. Apparently collected on the northern slopes of Kilimanjaro and on Meru in Tanganyika, also in other parts of Kenya. There is no information as to how this rubber was obtained nor any analytical data, but balls of it were submitted to a firm in Hamburg, who valued it at between 7 and 7.60 marks a kilo in 1900.

L. Kirkii Dyer (Kirk's Rubber).—An erect, but more usually a climbing, pubescent shrub with very variable leaves, both in regard to size and shape, 1 to 4 in. long and ¾ in. wide, lanceolate to oblong or ovate or elliptic; flowers in dense subsessile or somewhat loose, ovoid much elongated panicles, often passing into tendrils, flower small about 1/6 in. long; fruit obovoid-globose 1¼ to 3 in. in diameter, pale yellow when fresh with an orange-yellow juicy pulp. A variable plant of which there are two varieties, *delagoensis* Dewèvre, with small leaves, and var. *dondeensis* (Busse) Stapf, an erect form. A widely distributed shrub in forest patches and scrub of the coastal districts from Abyssinia to the eastern Transvaal and Zululand, in Northern Rhodesia and Nyasaland. In high-rainfall areas it has a climbing habit, but in drier parts assumes a bush form (var. *dondeensis*).

This is the most important rubber vine in East Africa. The stems are tapped by slicing off the bark, 2 in. wide rings being cut 18 in. apart as high as can be conveniently reached from the ground. The latex oozes slowly and is too thick to drop. The tapper carries a mixture of lime-juice and salt water, and when he is ready he dips his hand in the liquid and grasps each cut surface, causing the ring of the thickened latex to coagulate at once. The rubber is then collected by slowly rolling it off piece by piece until a large ball thus formed becomes too unwieldy; a fresh one is then started. Attempts to extract the rubber by mechanical means were unsuccessful. The yield of rubber averages 1 oz. per vine per annum, but varies greatly, principally with age. As much as 7 oz. has been obtained from especially large vines in Nyasaland.

Experimental tapping in Portuguese East Africa gave an average of about 28 grams at one tapping during the dry season and 120 grams during the wet season. Other experiments indicated that the yield of rubber varies from 30 to 200 grams per vine.

The Imperial Institute found its composition varied between 87.4 to 92.3 per cent caoutchouc, 5.9 to 10.9 per cent resin, 1 to 2.1 per cent protein, and 0.4 to 1.1 per cent ash.

L. owariensis Beauv.—A more or less glabrescent shrub, often very large, rarely a tree, with long hook-branched tendrils; leaves oblong, rarely elliptic or lanceolate, 3 to 6 in. long, 1 to 3½ in. broad, glossy above; flowers many in shortly stalked pyramidal or ovoid panicles, flower ¼ in. long, more or less hairy without; fruit round 1 to 2½ in. in diameter, yellow mottled with red, the woody rind wrinkled. Originally recorded from Nigeria but widespread in West Africa and extending into Uganda and the Sudan.

Both the stems and roots yield latex, and there are various native methods of collecting it; tapping by incisions on the stems and roots and coagulating by lime-juice or salt water, also spontaneously; cutting the stems into sections and draining them of their latex; by the removal of the bark from stems and roots by beating, sun-drying and beating again, washing, then soaking for twelve hours and boiling, by which process it produces a red cluster rubber. Numerous experiments have been carried out on the best way of obtaining the rubber and yields. In the Belgian Congo, a seven-year vine, on tapping oldest stems and primary branches, yielded 18 grams of rubber,

beating of bark from tapped stems 37 grams, and beating of bark from untapped stems 8 grams, the total yield of rubber being 63 grams of which 45 grams were obtained by beating the bark. Other experiments showed that tapping or draining the stems yielded little rubber, as the latex is usually thick and does not flow freely. The best results were obtained by beating the bark. A number of analyses have been made on the composition of ball, biscuit and sheet rubber (dry washed) by the Imperial Institute; they range from 90.6 to 94.1 per cent caoutchouc, 4.4 to 6.2 per cent resin, a trace to 0.9 per cent protein, and 0.2 to 2.3 per cent ash. The rubber is said to be of excellent quality.

L. parvifolia K. Schum.—A much-branched glabrous climbing shrub with tendrils from the branch forks; leaves oblong to lanceolate, ¾ to 1¾ in. long by about ½ in. broad, leathery; flowers in small dense very shortly stalked corymbs, flower about ¼ in. long; fruit like a small orange, 1 to 2 in. in diameter, greenish purple. Recorded from *Brachystegia* woodland in Central Tanganyika, Northern Rhodesia, and Nyasaland.

The bulk of the rubber in this species is contained in the bark of the roots or rhizomes, which are dug up and exposed to the sun for some time in order that the latex may be completely coagulated. The bark has then to be removed, either by beating or by hand-stripping with a knife, or by soaking the rhizomes in water for two or three days and then beating. The bark is then dried in the sun again, after which it is given a series of beatings to reduce it to small fractions, the particles of rubber adhering together and forming a loose mass. If the soaking process is used the quality of the rubber is poor. Further beating is given to eliminate as much of the bark from the rubber as possible, and the final stages are a series of mascerations of the rubber in boiling water to facilitate the removal of vegetable matter until a rubber of the desired purity is obtained. The rubber, whilst still soft, is pressed into balls or cylindrical rolls with the hands.

The methods described above are also employed by the natives for the extraction of rubber from the stems of some other species of *Landolphia.*

A number of machines have been designed to perform these processes, and one was in use in the West Nyasa District of Nyasaland, when a comparatively pure rubber was obtained and exported as crêpe. It was examined by the Imperial Institute in 1911 and valued at 3/9 to 4/4, against Para quoted at 5/2½ per lb. On the other hand, analysis by Berlin University in 1909 gave 0.78 per cent insoluble matter, 13.60 per cent pure caoutchouc, 75.20 per cent resin, and 10.20 per cent moisture, and it was condemned as of no use by a German rubber expert. This raises a doubt whether the Berlin sample was obtained from authentic *L. parvifolia.*

L. Stolzii Busse (Kondeland Rubber).—A more or less glabrous shrub, climbing with long hook-branched tendrils; leaves ovate to ovate-oblong, papery to thinly leathery, 1½ to 3 in. long by 1 to 1½ in. broad; flowers in dense cymes in terminal panicles up to 3 in. long, flower up to ¼ in. long, very shortly stalked; fruit resembling a small orange. Recorded from damp forest near water at Ipyana in the Tukuyu District, Tanganyika, and apparently common in that region.

A rough native method of collecting the latex is to cut the stems into sections and drain them, but the usual methods of tapping, preferably with zigzag cuts, are best. The vines yield a thick latex (75 grams per month from an individual vine have been recorded) which coagulates spontaneously and is stripped off into balls. There does not seem to be any analytical data about its caoutchouc content.

L. ugandensis Stapf (Nandi Rubber).—A glabrous or very slightly pubescent climbing shrub with long slender branched tendrils from the branched forks; leaves oblong to ovate-oblong, 2½ to 4 in. long, and 1 to 1½ in broad, papery, slightly glossy above; flowers in dense, 12 to 16 flowered short corymbose racemes; flowers shortly stalked over ½ in. long in bud; fruits the size of an orange. Originally recorded from Uganda, and found in heavy-rainfall forests of the eastern slopes of Mt. Kenya, Nandi District and the Nyanza Basin and on the western slopes of the Mau, and said to be found in Nyasaland. In Kenya, considerable quantities of this rubber were collected for export, but tapping declined as the prices paid for it were not worth its collection. An Imperial Institute analysis gives on material as received, 78.3 per cent caoutchouc, 9.1 per cent resin, 6.2 per cent moisture, 6.4 per cent dirt and insoluble matter, and 2.4 per cent ash; calculated for dry material, 83.5 per cent caoutchouc, 9.7 per cent resin, 6.8 per cent dirt and insoluble matter, and 2.5 per cent ash—a rubber of good quality.

L. lucida K. Schum.—A Congo plant, said to be found in the Usambaras, Tanganyika, and the Shimba Hills, Kenya.

L. Watsoniana Vogtherr.—Apparently restricted to the coast belt of Tanganyika. Both species are said to contain good rubber, but about which little is known.

Mascarenhasia elastica (*Mgoa Rubber*)

A much-branched glabrous evergreen tree up to 40 ft. tall, with a somewhat rounded crown; leaves opposite, oblong-obtuse, 3 to 10 in. long by 1½ to 2½ in. broad, leathery; flowers in few-flowered axillary cymes from the axils of the leaves, flower tubular, not very conspicuous, cream or yellow, about ¼ in. long; fruits cylindrical, in pairs at right angles to each other on a common stalk, filled with linear oblong seeds, each of which has a tuft of short silky pale brown hairs. Originally recorded from Dar es Salaam, but an occasional tree in swampy places and on streamsides in the coastal belt extending into the Shimba Hills, Kenya, Pemba, and down into Portuguese East Africa.

The rubber is usually obtained by making incisions in the stem and branches and allowing the latex to coagulate spontaneously in the cuts; the strips of rubber thus formed are then wound off into balls. Attempts to obtain the rubber by mechanical means from another species were unsuccessful.

Analyses by the Imperial Institute are:—

	Kenya	Pemba	Portuguese E. Africa
	Per cent	*Per cent*	*Per cent*
Caoutchouc	76·6	85·2	92·1 (80·1)
Resin	6·8	9·0	4·6 (8·1)
Protein	3·9	3·7	2·4 (3·9)
Insoluable matter ..	12·7	2·1	0·9 (7·9)
Ash	2·45	1·29	2·0

It will be observed that the Portuguese East African and Pemba percentages are good; the Kenya sample has too many impurities and could not have been carefully collected. The figures in brackets show the range in other Portuguese East African samples examined by the Institute.

It is said that, if carefully collected, the rubber is of satisfactory composition and good quality, but the latex flows so slowly that its collection is not profitable. In any case, as the trees are never found in large pure stands the collection of this particular rubber by itself is not worth while.

Holarrhena microterantha K. Schum.

Apparently a rubber plant that has appeared in trade reports. Unfortunately, little is known about it, but it is believed to be recorded from South-east Tanganyika.

With the conquest of Malaya by Japan and her attacks on Java, the rubber resources of the free peoples are severely strained. The old Para and Ceara rubber plantations in East Africa are now being exploited, and no doubt wild rubber will also play its part.

The question is, how quickly could bulk production of wild rubber be undertaken? It has to be remembered that the present demand for rubber of any kind must lead to a renewed interest in wild sources. Vegetation communities in which wild rubber plants flourished have been much reduced by clearing both for native and plantation crops. The native to-day is more sophisticated than he was; he has his cash crops and can find employment in towns or on plantations where he can easily earn his hut and poll tax. It is also reported that there is a shortage of labour for plantation work, and that the African does not work as hard as he might do according to European standards. There is therefore not the incentive for an African to go into the bush collecting wild rubber as he did in the past.

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ARSENICAL POISONING OF STOCK (*Continued from page* 223)

animals, egg-white. Drinking water should be restricted, and may with advantage be replaced by milk or hay tea. Soft scalded mashes and gruel should be offered rather than dry food. Once the antidotal treatment has been given, good nursing plays an important part in promoting recovery.

The chances of curing the animal depend on the amount of arsenic that has been swallowed, the form in which it has been taken, and the delay before the antidote is given, as well as on the vitality of the patient. Arsenic in the form of sodium arsenite in dips and hopper-bait is very easily absorbed. This fact accounts for the marked difference in the results obtained by early and late treatment in the Kabete experiments.

AFRICAN LABOUR ON THE FARM IN KENYA COLONY

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The farmer has much to complain of to-day in regard to farm labour. While labour is scarce in many districts and there is an apparent reluctance amongst Africans to leave the reserves to work on European farms, the output of individual labour appears to be deteriorating.

Even if allowance is made for ill-health, especially due to malaria and tapeworms, the primitive East African is not usually notable for the ambition and restless energy which is characteristic of the Nordic peoples. The needs of the unsophisticated native are few and easily satisfied; when his annual hut and poll tax of ten or twelve shillings a year is paid, and one or two pairs of khaki drill shorts have been bought, the bulk of his routine needs for cash have been met.

There is a tendency therefore for the average labourer to seek employment on farms where the tasks are known to be light and the daily hours of labour few, even though the wages are lower than on other farms where the work is more heavy. On some farms the labourers will do little work at all unless given a definite task, and often even a moderate day's task is left unfinished. Many a farmer complains that he would willingly pay double the wage could he obtain a reasonable output of work from each man.

The partially educated African has a greater number of needs for which cash is required. However, his output of agricultural work is apt to be no larger than that of his more ignorant brother; he is dissatisfied with current agricultural wages, and he usually seeks clerical employment in the towns or, failing this, on the farms.

Not only is the output of the African labourer low in quantity, but, unless very closely supervised, it is usually, though not invariably, slipshod. There is little of the pride in a job well done which was characteristic of the old-fashioned English farm labourer; to beat the clock or to escape the overseer's eye is a common aim.

At the present time, discipline amongst agricultural labourers is often very bad, especially where the European owner or manager is away from the farm owing to the war. The African farm labourer is notoriously careless with expensive tools and machinery, while the theft of small tools is regarded as fair game should the system of issuing and checking tools on the farm be lax. Stealing of crops, fruit and vegetables from the field, garden or store is rife, and may be a considerable source of loss and annoyance to the farmer.

The brewing of *tembo*, or native gin, from maize meal, honey, sugar or sugar-cane, though now prohibited by law, is still common on many farms, and there is much drunkenness during the week-ends. This means waste of money which is required for useful expenditure on food and clothing, and an inefficiency and dullness on the following Monday which is, to say the least, irritating to the farmer.

Despite various ordinances and regulations, the labourer, especially the "squatter" or resident labourer, is often likely to take a nonchalant view of his obligation to his employer and to work only when it suits him. The employer, on his part, cannot always afford to deal with such indiscipline in a stringent manner owing to the difficulty of obtaining labour of any description.

So much for the farmer's case. The African labourer also has a case. He may not be able to voice his dissatisfaction coherently and logically. He may be conscious merely of vague dissatisfaction with his conditions. This discontent will become more defined as education becomes more general amongst the Africans.

Many of the native reserves are overcrowded to an extent which precludes agricultural improvement and social betterment. It is essential that numbers of Africans shall seek employment outside the reserves. The European agricultural industry is the greatest present and potential outlet for African labourers surplus to those who can find work in their own districts.[1] For this reason it is important that conditions of service should be bettered and the quality and quantity of labour improved to the mutual satisfaction of employer and

[1] According to the Special Labour Census compiled by the Registrar of Natives, Nairobi, in December, 1941, there were 143,550 natives engaged in agriculture at that time, including 84,955 registered natives, 36,899 unregistered, and 21,696 squatters. 60.94 per cent of employed natives, exclusive of public services, are engaged in agriculture, compared with 12.05 per cent "Domestic and Personal", 11.35 per cent "Mines Industries and Quarries", and 11.04 per cent "Commercial and Professional".

employed. It is the purpose of this article to focus attention upon existing evils regarding African farm labour, from the point of view of the good of the African—which ultimately must also be the good of the farmer—and to suggest some lines of approach towards changing the state of affairs for the better.

Present Conditions

Housing

While a few farmers have put up a better class of hut, the housing on most farms consists of thatched mud and wattle huts, deficient in light and air, often in bad repair, damp and rat-ridden.

It is true that housing in the native reserves is often little or no better; but this is no reason why conditions bred of dirt and ignorance should be perpetuated in European areas, and in many native reserves the Africans are beginning to put up for themselves good brick or stone houses, with iron roofs.

An argument sometimes advanced in favour of temporary huts is that vermin may be destroyed periodically by burning the huts. This argument is specious, however, since the so-called temporary huts often are made to do service for many years, and it should be possible to control vermin much more easily in clean, well-built houses.

The real reason, of course, why better housing is not put up for African farm labourers is the high expense of so doing, especially where large numbers of workers are employed for the production of maize, coffee, sisal, pyrethrum and flax.

The European farmer, at the mercy of national politicians and international financiers as regards crop prices, has much ado in many years to cover his present costs of production without further adding to his "overheads".

Nutrition

The African labourer on the average farm is very poorly fed. His ration consists of 2 lb. of maize meal a day, often of poor quality, together with a small amount of salt. This diet he supplements with a little greenstuff such as *Amaranthus* sp. or "Pigweed", a *Crotolaria* sp., and other indigenous plants used as spinach. He rarely gets meat unless an ox is killed on his or a neighbouring farm, or on an occasional visit to town. Occasionally a buck is trapped, though this is illegal.

Milk is only obtained, normally, by "squatters" with cattle—which are usually low-yielding animals—and not by the casual labourer.

Meat, or dried fish, and beans are issued on some farms, especially on the tea plantations operated by wealthy companies, the standard of whose native wages, food and living conditions are usually considerably higher than those of the private farmer.

Sometimes farm labourers with some permanence of employment, including "squatters", are given shambas of their own to cultivate. In some areas these shambas are large, consisting of ten or twenty acres. The cultivation of this land, often on steep hillsides, is generally uncontrolled by the farmer, and the natives may produce large quantities of maize for sale, regardless of ensuing erosion.

Even on small patches of land the labourers usually grow maize or starchy foods like sweet potatoes, rather than protein foods such as beans, peas and other legumes, or vitamin-foods like carrots, tomatoes, lettuces, sweet peppers, onions or other vegetables. Little or no interest is usually shown by the farmer in this question.

As a consequence, the African labourers, especially the small children, often have a dry and cracking skin and generally unhealthy appearance, indicative of a diet deficient in meat, milk and vitamins. "Squatters" who own stock are generally in better health; but the presence of large numbers of squatter stock on the farm is not compatible as a rule with the development of a sound farming system by the European farmer himself.

Wages

The average wage for a farm labourer is about Sh. 8 a month for a 30-day "ticket", together with 2 lb. of maize meal a day, which may be valued at Sh. 2 or Sh. 3 a month. Small children of about 7 to 12 years old are paid Sh. 3 or Sh. 4 a month for light tasks such as pyrethrum picking. Labourers of long service or special skill may be paid up to Sh. 15 a month, headmen Sh. 20 or Sh. 30, up to Sh. 40 or Sh. 50 a month in exceptional cases. As Sundays are not paid for, the wage rate for the calendar month will be only about Sh. 6/90 for the average labourer.

It is evident that the lower-paid workers do not receive sufficient cash to supply an adequate diet for a single man as well as provide clothing and money for poll tax.

Many of the farm workers also have wives and families to support, though the latter may bring in additional income at times from piece-work, such as pyrethrum and coffee picking. The former is paid at 10 cents for a four-gallon tin (*debe*) of flowers with 15 lb. gross

weight, or about 12 lb. net, and the latter at 10 cents a *debe*. In a good season a good picker may earn as much as Sh. 5 a month at pyrethrum picking or coffee picking. On other farms, women are paid a wage of Sh. 4 or Sh. 5 a month, together with 2 lb. of maize meal a day, and are expected to pick two *debes* a day, or 60 *debes* for the 30-day "ticket". On one large tea plantation in Kenya wages range from Sh. 8 to Sh. 14 per month for adult unskilled labour, according to the length of service. Skilled or semi-skilled wages range up to Sh. 100 per month. Tea pluckers, mostly children, can earn up to Sh. 14 a month, with an average of about Sh. 8/50 or Sh. 9/50 a month. On another plantation the average daily pay, including the value of maize meal issued as rations, varies between 44.8 to 46.3 cents for male estate workers, and 50.4 to 54.3 cents for male factory workers. Women, not issued with maize meal and non-resident, earn from 36.4 to 61.6 cents a day. Female weeders are paid Sh. 1 for three days and pluckers 1½ cents per lb., which, with an average of 40 lb. per day per head, represents 60 cents per day.

Low as the wages are in the case of maize and coffee, low prices for the crop make it difficult or impossible for the farmer to pay higher wages, especially in view of the poor output of work from the individual African labourer, without forcing himself out of business or into the bankruptcy court. It is arguable that the successful pyrethrum farmer could pay higher rates; but the "marginal" farm for economic production would then be a farm at a much higher level of production and the total output of flowers from the Colony would be reduced considerably.

Water Supplies

The nature and amount of the water supplies available for the agricultural labourers for domestic purposes naturally will vary from farm to farm. In general, labour lines on farms are placed in such situations that water is available at no great distance. On other farms the water supply may be distant or dirty and polluted by stock. Shower baths are rarely provided for the labourers, and such ablutions as are performed are usually at the nearest stream, also the source of drinking water.

Firewood

Here again it is not possible to generalize, but there are farms on which little or no provision has been made for an adequate supply of fuel for the labourers, who are put to some difficulty in procuring it. As a result there is a tendency for the indigenous trees or bush to disappear or be mutilated on such farms.

Recreation

Numbers of farmers provide a football for the amusement of their labourers and a patch of rough ground for a football pitch of sorts, though on many farms space is cramped, since all flat or fairly flat portions of the farm may be under crop.

Apart from this there is rarely any attempt to provide amusements of any description for the labourers. The consequence is that labourers resort freely to the pleasures of alcohol, especially during the week-end. In addition to brews sanctioned by "permits" issued by the farmer, there is a great deal of crude "gin" manufactured without sanction.

It may be said that the African in the reserve also has little recreation. This is true, but he has a greater amount of social intercourse, especially when local markets or similar events are held.

Home Life

The average labourer, as distinct from the cattle-owning "squatter", rarely has his family with him. If he owns land or has a cultivation-right in the reserve, his wife will usually stay behind to cultivate his shamba while the man goes out to work for a few months to earn a few shillings to pay hut tax and buy a few clothes. A younger man may be earning money in order to remit shillings home to his father who, in time, will make arrangements about obtaining a wife for his son.

The food available and the money earned by the average labourer are rarely sufficient to support a wife and family on the farm.

In the circumstances prostitution, especially by women of the Nandi tribe and by Nubians, is common and is usually winked at by the farmer. Indeed in this regard the farm is no worse than the Municipality of Nairobi, with its overwhelming preponderance of males to females.

As is usual, prostitution brings in its train more venereal disease, causing loss of efficiency and absence from work.

Health

The farmer usually maintains a stock of medicine such as Epsom salts, cough medicine, quinine, iodine, etc.; indeed the farm labourer

is often better off in this respect than the African in some parts of the reserves. On some farms an unskilled medical dresser is maintained for the treatment of minor ailments of the labourers. Serious cases of sickness or injury are usually taken to the nearest Government native hospital. Labourers suffering from malaria rarely return for their doses of quinine sufficiently often to obtain a complete cure from the disease, and it is difficult for the farmer to check this indifference or ignorance on the part of the labourers. Tapeworm and hookworm are often endemic amongst Africans coming from the reserves. These parasitic diseases cannot be treated on the farm without risk; and a great deal of trouble and expense would be entailed to the farmer should he have to take many of his labour force, perhaps the majority, to undergo a course of treatment, lasting several days, in the nearest native hospital, which may be many miles away.

Shops

Many farms are twenty or thirty miles from the nearest town. Should the farm labourer wish to buy clothes, blankets, soap, cigarettes or other requirements, he may have to spend a day or two away, losing this time from his ticket. Often, however, there is an Indian *duka* or store on the farm or within a few miles of it. In other cases the owner of the farm runs a store for his labourers, often making a profit out of it; or very often an enterprising headman adds considerably to his income by keeping a small store to supply the simple needs of the labourers on the farm.

Schools

Small bush schools are often to be found on farms under the control of African mission teachers. These teachers, who are seldom likely to be qualified beyond the elementary school examination, are sometimes paid by the farmer, but not always, as a small charge may be made by the teacher for the schooling, which is of a very elementary and primitive nature.

Suggestions for Improvement

Housing

Permanent housing of brick or stone with cement floors is an ideal to be aimed at. If such houses are built there must be separate kitchens, in order that the insides of the houses are not spoiled by the smoke and heat of open fires. The plans, published by permission of the Commissioner of Prisons, Kenya, and prepared by Mr. Manley, Assistant Superintendent of Prisons, show a type of semi-detached house, with a thatched roof, suitable for a married employee, and a block of five single rooms suitable for bachelors. Small kitchens would be built separately behind these houses. The capital cost of the first building is likely to be about Sh. 800 on the farm; of the second, Sh. 1,000. Assuming a life of fifteen years, the housing for bachelors would cost only a little more than Sh. 1 a month per man plus a small allowance for repairs. However, the capital cost, though not high, is far beyond what the average farmer could afford for his labour force.

One solution might be to subsidize the farmer, either directly for the building of an approved type of quarters for labourers, or indirectly by subsidizing crop prices. This is a matter in which the Imperial Government possibly might be interested as a practical interpretation of trusteeship for the African native races.

Alternatively, quarters for labourers might be put up by contract or by Government and the whole or part of the capital cost recovered by Government over ten or twenty years by means of an addition to the land rent. Another plan would be for the existing land rents to be used for this purpose.

Cheaper and less permanent huts might be erected, still far in advance of those usual on farms at present. Huts of the type described by Graham in this Journal (Vol. 4, pp. 278-282, Jan. 1939) would consist of two thatched rondavels with glazed windows, cement floor, the walls cement-plastered and whitewashed inside and out, together with a small outside kitchen. The building of this cheaper type of hut, according to specifications, might be assisted by a subsidy, but owing to the impermanent nature of the building it would not be a fit purpose for a loan to be recovered over a long period.

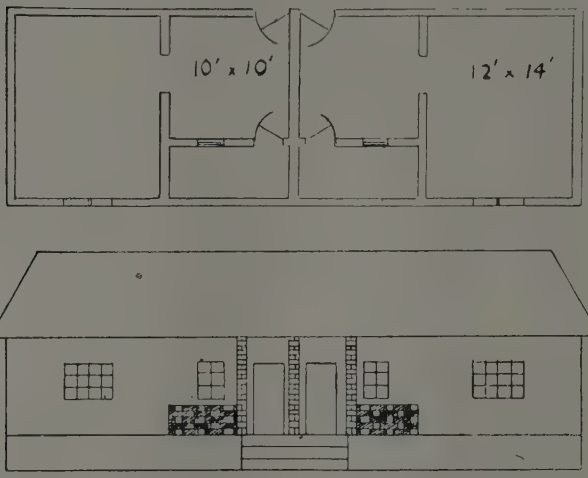
Wages

Here again the farmer is largely dependent on economic factors and international conditions over which he has no control. Whatever the lot of the industrial or transport worker, it has been the customary fate of the agricultural labourer, whether in Europe, America, Asia or Africa, to suffer low wages and low standards of life. Only when a price is paid for agricultural products, by international agreement, that is consistent with the costs of production and risks, can it be said that agri-

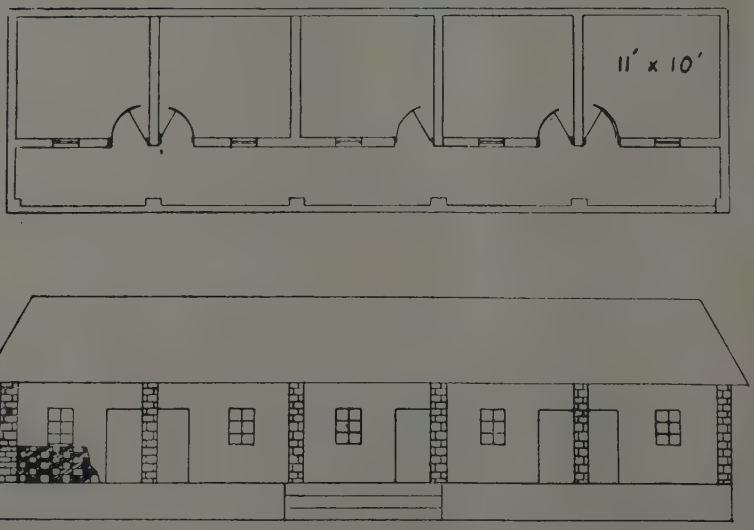
WARDERS' LINES, H.M. PRISON, KITALE

Burnt brick, mud mortar, cement-pointed outside and plastered inside; 14 in. foundations; 9 in. walls; brick floors, cement-plastered; batten doors; glazed windows; thatch roofs; gum-pole roof timbers; 4 in. by 4 in. door and window frames; 9 in. by 3 in. timber lintels.

Married Quarters



Quarters for Single Men



culture has been considered in its rightful place in balanced national and international planning. A reasonable standard of living for the families of both farmers and labourers must be considered as part of the costs of production for farm produce. Should planned production on an international scale and stabilized fair prices for farm products become more than an optimistic dream, minimum wage scales and maximum work hours must be fixed for farm workers; but such protection for the worker entails no less care in protecting the employer in order to ensure that a fair day's work is given for a fair day's pay.

Food

If wages remain on as low a scale as they are to-day, the farmer should provide better rations than are usual at present. A higher output of work might be expected as the direct result of better feeding. Notably meat, milk, beans and fat should be provided. It must be remembered, however, that a ration, to conform with the dietary recommended for a single man by the medical authorities, is likely to cost Sh. 5 or Sh. 6 a head more than at present, or almost as much as the present wages. To cover this additional cost it would be necessary for labour to be nearly twice as efficient as at present. Undoubtedly the farmer could use his labour more economically than he does, since the presence of low-paid labour gives no incentive for economy in man power.

Most farmers who keep cows and pigs feed all their surplus skim milk to their pigs. While skim milk is of great value in pig production, there seems something wrong in the sight of fat, complacent pigs on a farm where the labourers' children are thin, grey of skin and unthriving in appearance. At least a portion of the skim milk should be made available for the labourers, especially the children.

On many farms, particularly where dairying is not an integral part of the farming activities, a few "squatter" families often monopolize all the grazing and milk supply. It would be far better for the farms and the farmers if such cattle were the property of the farmer. In this event, whether the cows were regarded primarily as manure-making machines, or whether cream was sent to the creamery, the pasturage would be better looked after and skim milk would be available for distribution amongst the labourers and their children rather than milk being the daily perquisite of only a few half-time, reluctant and elusive "resident labourers"—a connotation which too often deludes in suggesting a steady, plodding, reliable farm worker.

The farmer should refuse to allow maize to be grown in the labourers' gardens. Maize in the native gardens provides unnecessary starchy food and little else. It gives a convenient excuse for the presence in the houses of maize stolen from the field or crib. Seed of beans, peas and carrots should be issued. Plants of tomatoes, onions, cabbages and sweet peppers could be raised in the farm nursery and issued to the labourers. One farm "boy" could be made responsible for seeing that these vegetables were properly tended and failure for a labourer to do so would be a punishable offence.

The presence of small buck is often mainly responsible for lack of more enterprise in cropping on small native gardens on farms. Hedges of sisal, Kei apple, or *Lycium horridum* would have to be planted to protect the crops against marauding animals.

Natives on farms should also be encouraged to keep chickens to provide an addition to the protein side of the diet.

The theft by natives of berry fruit, pineapples, bananas, pawpaws, and grenadillas is a sore point with many a European housewife. While casual labour cannot easily be induced to look after fruit trees, it should be possible to distribute fruit trees of all kinds amongst labourers whose service under better conditions is likely to be fairly lengthy. Until the practice of tending these fruit trees became routine and the benefits fully appreciated, failure to look after them would have to be considered a breach of farm discipline, and punishable as such.

Water Supplies

It should be considered obligatory on the farmer to provide his labourers with an ample and convenient supply of clean good water. Piped dams or springs may provide the water on some farms; on others, shallow wells or even a borehole may be necessary. Whatever the source of supply, it should not be a mere muddy hole, trampled by cattle and infected by man and beast.

Firewood

Gum plantations of sufficient size to provide an adequate and continuous supply of firewood for the labourers should be planted on every farm. The wives of the Africans should not be left to forage for firewood and their husbands to destroy any indigenous trees convenient to their huts.

Shops

Shops should be established on each large farm or group of farms at which goods, bought direct from the wholesalers or importers rather than through a series of middlemen, should be sold to the labourers as cheaply as possible. These shops should not be regarded as profit-making concerns for the farmers or their headmen—even if existing shops are not run in the notorious fashion of the stores on the cotton plantations of the Southern States of America, where the wretched tenant or share-cropper never quite succeeds in clearing his debts to the store. Rather the farm shops should be considered as social necessities of the labourers, being conducted on a co-operative profit-sharing basis, or so that all profits made should go to a farm "betterment fund' to provide amenities for the labourers and their families.

Recreation

The provision of recreation is no easy matter but is well worth trouble in order to obtain a happy and contented labour force.

First of all, private brewing of liquor should be forbidden. The only beer allowed on the farm should be beer of known alcohol content, made specially for native consumption, such as that manufactured and sold in Nairobi. This beer should be sold in a well-regulated beer shop, and the profits from sales devoted to the "betterment fund".

Some trouble should be taken over the organization of team games, such as football. Cricket has not been popularized amongst Kenya natives, but in the West Indies wildly enthusiastic games may be seen in progress at the week-ends on every small patch of grass-land.

A large *banda* might be provided, possibly out of the "betterment fund", in which games might be played and dances held for the younger people.

Farm or inter-farm sports might be organized once a year, including non-athletic events. It is probable that physical culture classes would be attended by the younger men in the evenings or at week-ends.

Health

Apart from malnutrition and pulmonary disorders due to ill-ventilated, overcrowded, smoky dwellings, the most common causes of ill-health amongst farm labourers are probably malaria and intestinal parasites.

Each farm in areas where malaria is endemic should allot a boy specially for anti-malarial work. He would attend to the oiling of stagnant water, the spraying of houses, the administration of quinine to people sick with malaria, and the reporting to the farmer of parts of the farm where drainage or clearance of vegetation was required to facilitate the control of the Anopheles mosquito. Such boys might be given a short course of training at the nearest office of the Medical Department and their work inspected and reported upon periodically by itinerant trained Africans of the Medical Department.

As regards intestinal worms, the problem is a little more complicated, in view of the rather dangerous nature of the treatment. As preventive measures, all labourers on the farm should be impressed with the necessity of cooking their meat well. Latrines should be provided and their use insisted upon.

It should be possible to arrange for a travelling van of the Medical Department to visit farms regularly and administer a full course of drugs to all natives suffering, or suspected of suffering from parasitic worms.

Home Life

If agricultural labour is to be permanent—and permanence is of inestimable value to the employer—family life must be encouraged.

Housing must be sufficient, ample and comfortable to permit of wives and families living on the farm; the provision of milk, better rations and good vegetable gardens should do much to encourage a more settled outlook on the part of the farm labourer. He should have his chickens; possibly a pig.

A large farm or group of farms should be able to provide a female African welfare worker. As well as visiting the sick and giving pre-natal advice to expectant mothers, such women, who might be trained by the Medical Department, could teach cooking to the wives and hold classes in knitting and needlework. In addition, by individual advice and by holding classes, women of this kind, if trained suitably, could teach cleanliness and hygiene, and the care of children, to the uneducated wives of the labourers.

The provision of a good water supply, essential to health, has already been mentioned. Wherever possible, shower baths should be erected for the use of the labourers and their families. The inevitable initial misuse of such

amenities by ignorant Africans must be regarded as of no more ultimate importance than the oft-quoted bogey of the "coals in the bath" of the unregenerate English slum-dweller.

Schools

Lack of suitably qualified elementary teachers is a drawback at present. However, it might be possible for the Education Department to lay down a suitable salary scale and skeleton syllabus of work for farm schools. Then, if a large farm or group of farms had provided a building approved by the Education Department and had agreed to pay a certain sum annually towards the cost of a suitable teacher, the Education Department might make an annual grant of a standard amount to supply the remainder of the teacher's salary. In such a case it would be necessary for a certain minimum number of pupils to be guaranteed.

Special African assistant inspectors might be appointed by the Education Department to visit the farm schools.

It is probable that adult evening classes in reading, writing, arithmetic and English would be popular amongst farm labourers if organized by the farm teacher. The labourers might pay a few cents weekly for this tuition.

CONCLUSION

The conditions of service of African labourers on European farms in Kenya Colony are far from satisfactory, and lag behind even the patchy improvement in living conditions to be seen in the native reserves. At the same time, the African labourer is unreliable, dilatory, and rarely understands the meaning of an honest day's work.

These two problems must be treated concurrently. Government assistance is required in both directions, though the latter problem would largely solve itself had the African more education and pride in himself.

It is no use abusing the farmer, at the mercy of an unequitable economic system, for all the present evils. The State must bear some responsibility and help the farmer to rectify the position. However, there are many things the farmer might do to improve the labourer's lot in the meantime, which require little expenditure of cash, but merely some thought, sympathy and organization; the African, on his part, must acquire that social discipline and sense of responsibility to his employer, his fellows and his subordinates without which he can never become part of a civilized society.

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"AGRICULTURALIST"!

We did not expect to see in a circular from the National Farmers' Union the spelling "agriculturalist". On writing to its alert general secretary he said that, though he had no strong feeling in the matter, he preferred this form to "agriculturist", and pleaded that both forms were given by the Oxford Dictionary. ("Agriculturalist" is defined as "one engaged in agriculture"; "agriculturist" as "at first a student of the science of agriculture, later a farmer".) The *Countryman* has always chosen "agriculturist" because that seemed the proper name for a man who practised agriculture; why turn an adjective into a noun? Besides, "agriculturist" is shorter. Also, as Fowler says, "the shorter form, besides being less cumbersome, usually corresponds more naturally to the sense; expert in agriculture (-turist) is simpler than expert in the agricultural (-turalist)". The Ministry of Agriculture writes "agriculturist". So, we find, do agricultural authorities like Sir Daniel Hall, Dr. C. S. Orwin, Dr. J. A. Venn, Professor J. A. Scott Watson, Professor F. L. Engledow, and the farming-editor of *The Times*. The Director of the Agricultural Economics Research Institute tells us that *The Druid*, writing as far back as 1870, used "agriculturist". Major Amery, of the Oxford School of Rural Economy, who has a remarkable collection of old agricultural books, is also for the shorter word. "It is," he says, "very much the older form and was almost invariably used until mid-nineteenth century, and it is certainly employed by the best writers to-day."

An early American agricultural work was called "Arator", which makes one wonder why that word was never used as a change from the overworked "agriculturist" and "agriculturalist". The dictionary gives aration (1663) for plough, but not arator.

The Countryman.

[We may guess that "aration" never established itself, partly because it was too like "aeration" (which had nearly a century's priority), and "arator" because it was too like "orator".—*Ed.*]

THE USES OF PASPALUM NOTATUM IN UGANDA

By A. S. Thomas, B.Sc. (Hort.) (Lond.), M.Sc. (Reading), A.I.C.T.A.,
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In order that the stock industry of Uganda may be developed for the production of both meat and milk, it is highly desirable that a system of paddocking should be utilized near the larger towns. For these paddocks grasses are needed that will form a lasting even sward under heavy grazing. About five hundred distinct species and varieties of grasses are known to occur in the Protectorate; these include a wide range of forms and most of the more valuable tropical fodder grasses; yet few of them will form a good sward when heavily grazed.

There are, however, some indigenous grasses which do form a sward under certain conditions. *Pennisetum clandestinum* (Kikuyu grass) makes excellent pastures at altitudes of about 6,000 to 7,000 ft. on Mount Elgon and in Kigezi. *Digitaria scalarum* (Couch grass) forms a thin sward, which seems to be very palatable although it does not yield a large bulk. *Brachiaria decumbens,* when it is growing on good soil with a well-distributed rainfall, as at Fort Portal, makes a good turf. In some places in Karamoja there are good natural pastures of *Cynodon plectostachyum* (Star grass), and this species forms excellent leys in the rotation practised on the Ngetta farm near Lira. On some of the landing places by Lake Victoria, both on the mainland and on the Sese Islands, close grazing by hippopotamus has formed a sward of *Axonopus compressus,* but this grass seldom persists at any distance above the water level.

Most of these indigenous grasses will withstand heavy grazing only if they are growing on relatively fertile soil. There is a heavy and increasing pressure on land near towns in Uganda, and the best soil cannot be spared for pastures because it is required for food crops. None of the grasses mentioned above will persist on poor soil, nor will any other indigenous good grazing grasses. *Eragrostis Mildbraedii,* which forms a close cover on some poor wet soils, is unpalatable to stock and appears to have a small nutritional value.

There is, however, one exotic grass—*Paspalum notatum* Fluegge—which shows promise of forming quite good pastures even on relatively poor soils. This species is native to South America, where it is one of the most important constituents of natural grasslands, as has been described by Davies [1], who states, "The general impression gained in the La Plata Basin was that Paspalum is among the most valuable of all grasses."

Paspalum notatum was introduced to Uganda by the Veterinary Department, probably by U. F. Richardson, before 1924. It seems to have been first planted at Entebbe, where, with the abundant rainfall, which averages 60 inches per annum and is well distributed, and in spite of the relatively infertile soils, the grass flourishes and is becoming naturalized. This species of *Paspalum,* if left uncut or ungrazed in Uganda, has the unusual quality of flowering once, about four or six months after it is planted, and thereafter not flowering again; it is remarkable therefore that it should become distributed as much as at present.

Paspalum notatum is usually propagated by planting short pieces of the thick stolons (runners) by which it spreads. If these pieces are planted firmly they root readily and grow into small tufs which, after flowering commence to spread fairly rapidly. If the grass is left uncut and ungrazed it forms a dense mass of leaves, about nine inches high; when it is grazed it makes a turf with a mat of large stolons covering the ground and with broad flattened hairy leaves, about four inches long and half an inch wide. If the grass is dug up the extraordinary development of the root system is disclosed; in a short time there is formed a mass of roots going straight downwards even on heavy compact soils.

On account of these deep roots, the grass resists dry weather fairly well and is not affected by drought so much as most native grasses; for there are few, if any, indigenous creeping grasses with so massive a root system. Paddocks of *Paspalum notatum* on Mr. Lea-Wilson's Namutamba Estate, Mityana, were established over eight years ago by dibbling pieces among Elephant grass, which was growing wild; when the *Paspalum* had rooted, grazing was started and the Elephant grass was soon killed, leaving a sward of *Paspalum.* This sward has persisted, and beyond the seasonal cutting out of tall unpalatable weeds, such as *Erigeron linifolius,* and the occasional

spreading of kraal manure, it has received no attention. No other grass has competed with the *Paspalum notatum* except *Sporobolus pyramidalis,* whose coarse upright tufts appear in many Uganda pastures when they are heavily grazed. The milking herd at Namutamba flourishes and gives good yields on the *Paspalum* pastures, but for young stock pastures of Kikuyu grass are used, and even mature stock much prefer this species. It is difficult, however, to keep Kikuyu grass pastures in good condition at Namutamba (the altitude is about 4,500 feet and the average rainfall about 45 inches) and the grass needs careful management and manuring if it is to persist. In time of drought Kikuyu grass suffers greatly, whereas *Paspalum notatum* keeps green and grows better than any local grasses.

W. S. Martin has shown that the root action of grasses on soil structure is a major factor in restoring and maintaining soil fertility in Uganda. It may be expected that the stronger the root system of a grass the more beneficial will be its action on the structure of the soil; trials of *Paspalum notatum* in comparison with other grasses therefore are being started. Experience already has shown that *Paspalum* produces such a mass of coarse roots that the structure of a compact loamy soil is much improved, and that when *Paspalum* turf is dug into the soil such a mass of organic matter is added that plant growth will be stunted for a period, on account of nitrogen deficiency, unless a heavy dressing of nitrogenous manure is given at the same time.

There are other uses for *Paspalum notatum* in Uganda. For one thing, it is quite a good coarse lawn grass; in fact, it seems to be the most useful grass yet tested at the Botanic Gardens, Entebbe. Plots of the most promising species were laid down there in 1933 to test their values as lawn grasses, and under the Entebbe conditions no other grass proved such a success. The plot of *Paspalum notatum* has retained a good cover and has remained free from weeds. The grass has invaded some of the other plots and has spread through them; this power of being able to spread through other established grasses is being utilized in the Botanic Gardens, and *Paspalum notatum* is being dibbled through the thin poor turf of old lawns (in which *Hyparrhenia filipendula* is abundant) in order that a thicker sward may be formed.

It is becoming evident that *Paspalum notatum* will not be a good lawn grass in places where severe droughts are experienced; for even at Kawanda, near Kampala, with an average rainfall of about 40 to 45 inches per annum, its growth has not been so good as at Entebbe. Furthermore, it has been found that the grass will not last well if it is cut very short, and that, like all other grasses, it requires manuring and top-dressing if the best results are to be obtained. Yet, with all its faults, no more useful lawn grass for the Kampala neighbourhood has yet been found. *Paspalum notatum* forms an even turf, the dark green colour is retained quite well in dry periods, and the general aspect is very pleasing to the eye. Unfortunately, the coarse leaves and thick stolons render *Paspalum* of no use for golf greens, and finer grasses, especially forms of *Cynodon Dactylon,* must be used in such places; such grasses require constant attention and manuring if the greens are to be kept in first-class condition.

Paspalum notatum does not spread so quickly as many other procumbent grasses, and when it is planted to make a lawn care should be taken that no soil wash occurs before the cover is formed. Weeding between the young plants of *Paspalum* is unnecessary, and has a bad effect, as it tends to make the ground uneven, with humps wherever the grass has been established and with hollows in the bare spaces. This drawback of slow spreading may be counteracted by interplanting the *Paspalum* with a coarse quick-spreading type of *Cynodon Dactylon,* which after a year or two will be displaced by the *Paspalum.*

A good *Paspalum notatum* lawn has been established at Entebbe by planting runners at a spacing of about two feet and then interplanting with Sword bean (*Canavalia ensiformis*). The Sword bean was allowed to grow unchecked until the first fruits were formed; it was then slashed and the leaves and stems allowed to lie on the ground to form a cover. No weeding was done. About a year after the time of planting, the mass of weeds, *Paspalum* and other grasses was slashed and then cut with a lawn mower, set high; a few clumps of coarse grasses such as *Panicum maximum* were cut out and in a short time a pure even turf of *Paspalum* resulted—and there had been no soil wash, although the site was sloping.

Last, but not least, there is the value of *Paspalum notatum* in anti-erosion work. It is highly desirable that there should be a grass cover on roadways, ditches and bunds, but in the wetter parts of Uganda such strips of grass

often serve to harbour the local Couch grass (*Digitaria scalarum*), which is such a pest among cultivated crops and whose eradication is so expensive. The control of Couch grass is a major problem of agriculture in Uganda, and in the past two methods have been employed: firstly, costly deep and thorough cultivation, and secondly the use of shade such as provided by a ground cover of *Leucaena glauca* in Robusta coffee plantations and by Elephant grass (*Pennisetum purpureum*) on resting land.

But observations at Entebbe and Kawanda have shown that in *Paspalum notatum* we possess a plant which can beat *Digitaria scalarum* in its own ground. Mention has been made of the thick mass of roots produced by *Paspalum* grass—roots with which few weeds can compete—and it appears that even the rhizomes of Couch grass must give up the struggle with them if the *Paspalum* is growing well. When *Paspalum notatum* has been planted in land infested with *Digitaria scalarum* the former has increased and the latter has diminished until it is impossible to find it in the mass of *Paspalum*, although the Couch grass persists, for some time at any rate, near the cut edges.

A most fruitful source of erosion in this country has been the system of ditches made around plots on native farms, ditches cut down to the subsoil to prevent invasion by Couch grass. There is no need for these ditches; for strips of *Paspalum notatum*, about three feet wide, appear to function well as barriers to Couch grass and, in addition, these strips will serve as pathways. On European estates wider strips can be made to serve as roadways; once a cover of the grass is established, the upkeep of these strips is not expensive, for the grass does not seed and spreads slowly above ground; Couch grass, on the other hand, seeds abundantly and spreads quickly underground. The *Paspalum* forms a mat of leaves only about nine inches high if it is left uncut; if a shorter turf is needed it may be slashed at intervals or cut with a mowing machine. For ditches and spillways, also, *Paspalum notatum* seems to be an excellent grass, holding up the silt and slowing down the flow of water; the run-off from sloping lawns of *Paspalum* seems to be negligible, even in times of heavy storms. On account of the relatively slow growth of *Paspalum* it is better that a rapidly growing grass such as Star grass or Elephant grass should be planted together with *Paspalum notatum* if it is to be used in gully stopping.

Although *Paspalum notatum* has such a mat of roots, the lateral spread has not been found to be more than about a foot. This species therefore may be used on bunds, where it will not produce such a marked border effect as will larger grasses (for example, Elephant grass) that have a spreading root system. Bunds planted with *Paspalum notatum* on the Bukalasa Experiment Station have produced a marked terracing effect, for the grass holds up and roots into any soil which may creep down. The grass spreads so slowly that the cost of cutting back the edges is not great, and it is showing so much promise of value on bunds that it is being utilized in other places for soil conservation. *Paspalum notatum* withstands the effects of heavy grazing and of fire, and therefore it should be of great value for the permanent demarcation of contour strips and bunds.

It is fortunate for Uganda that a grass, introduced originally for pasturage, has proved to be so suited to the wetter parts of the country and to be of such value in many ways. If one exotic grass has proved so useful, other exotic species also may be of value. Kikuyu grass, exported from East Africa, has been of great benefit to agriculture in other parts of the world. We may be able to import other species which will be valuable in our drier areas where, apart from Star grass (*Cynodon plectostachyum*), there is a shortage of good grazing grasses. Most of our East African deserts and semi-deserts seem to be of fairly recent origin, and it is possible that we may be able to obtain from older desert areas grasses which have become adapted to very dry conditions. While it is obviously of primary importance to study closely the forms and the requirements of local grasses, the possibility of plant introduction as a means of improving pasturage must not be overlooked.

REFERENCE

Davies, W.—"The Grasslands of the Argentine and Patagonia," Imperial Bureau of Pastures and Forage Crops, Aberystwyth; Herbage Publication Series Bulletin 30; 1940.

(*Received for publication on 3rd November*, 1940.)

Paspalum dilatatum Poir., growing on poor acid soil at Amani, shows similar good qualities to those described above for *P. notatum*.—ED.

NOTES ON ANIMAL DISEASES

XIV—BACTERIAL DISEASES OF STOCK

Compiled by the Veterinary Department, Kabete, Kenya

Anthrax and Anaerobic Infections

Anthrax

Anthrax is a specific disease caused by a large bacillus, *Bacillus anthracis*. This organism occurs in most parts of the world, and particularly in warm, moist climates, can persist in the form of spores for long periods in the soil. *Bacillus anthracis* is capable of causing infection in most mammals, including man. Birds are more resistant, and poultry can be infected only when the body temperature is lowered by immersion in water. Outbreaks have been recorded, however, in ostriches when these birds were farmed for their feathers.

Man may contract infection in three ways: for example, by inoculation, through cuts and abrasions when making a post-mortem examination or handling pelts, by inhalation of dry spores into the lung giving rise to the condition known as wool-sorters' disease, or by ingestion. In animals, ingestion is the usual method. Cattle can become infected by inoculation by bloodsucking flies, or, when vaccination is being practised, infection may be spread to clean animals by the hypodermic needles if these are not sterilized between each inoculation. Similarly infection may be spread by inoculation when shearing sheep.

Anthrax occurs in animals of all ages, but cases are relatively rare in calves and other unweaned stock.

Forms of the Disease and Symptoms.—In cattle two forms of anthrax occur, acute and sub-acute. Symptoms in the acute form are rarely observed, the animal usually being found dead. Dysentery is sometimes present. Cows in-milk may cut their yield the day before, and if the temperature is taken it may be found that fever is present. The febrile reaction is, however, very short, and the time from infection to death is probably less than four days. In the sub-acute form there is swelling of the throat, which may last as long as five days before death supervenes.

In sheep the acute form is usual, the animals dying with few or no premonitory symptoms.

In pigs and horses the sub-acute form is the more frequent, the majority of cases showing swelling of the throat.

Infection is very rare in dogs, and takes the sub-acute form. In man the commonest form is malignant pustule, a lesion like a boil, which usually has an intensely congested ring around the base. Shortly after the pustule appears a burning sensation is experienced in the relative lymph glands; for example, when the pustule is on the hands, the glands in the armpits are affected. Needless to say, a doctor should be consulted at once. In East Africa it is not uncommon for natives to contract intestinal anthrax from eating the flesh of cattle that have died from the disease, and often the infected native may recover after a severe illness. Generally infections in man in East Africa are less fatal than is usual in Europe or America.

Post-mortem Lesions.—A post-mortem examination should never be made if anthrax is suspected. Apart from the danger of infection to the operator, opening of the carcasses leads to increased infection on the farm. Anthrax bacilli will not sporulate in an unopened carcass, and in the unsporulated form are rapidly destroyed by putrefaction. When the carcass is opened, however, the spilt blood absorbs oxygen and the bacteria are enabled to form highly resistant spores.

If a carcass is opened inadvertently the lesions first observed are the black, tarry blood, the enormous spleen with black pulp, and the black veining of the lungs. These lesions should be sufficient to stop further examination.

In sub-acute cases the swelling of the throat will be found to be due to presence of a straw-coloured, gelatinous exudate beneath the skin and amongst the tissues.

Whenever death occurs suddenly with blood-stained froth from the body orifices and great distension of the carcass, anthrax should be suspected.

Diagnosis.—A blood smear should be taken by cutting off an ear and making a smear from the blood in one of the veins. The carcass and ear should then be burnt without further cutting. If burning is not feasible, a *deep* hole should be dug and the carcass and ear buried. The disposal of the animal should be supervised and not left to farm labour.

Control.—Since treatment is not possible, anthrax must be controlled by quarantine and vaccination. Ranched stock should be moved to a clean boma and the old boma should be

burnt. Any ground fouled by discharges from a dead animal should be covered with dry grass or brushwood, which should then be burnt. Permanent buildings should be disinfected with a blowlamp or a strong solution of a cresol disinfectant.

The vaccine now issued by the Kabete Laboratory is prepared by the technique introduced in South Africa following the recent brilliant investigations of Sterne at Onderstepoort. The vaccine may be used with safety on all animals. A slight swelling may occur at the site of inoculation, but this is not due, as it was with the earlier vaccine, to the anthrax bacilli in the vaccine.

When vaccinating a number of head, the needle should be changed and sterilized after the inoculation of each animal. This rule is often neglected when large numbers are being dealt with, but should never be disregarded when vaccinating to control an outbreak of anthrax. The fact that an animal has died of anthrax on a farm implies that others in the herd may be already infected, and may therefore have enormous numbers of bacteria circulating in their blood.

Bacterial vaccines generally confer a relative immunity only, and a dose of anthrax vaccine will not give absolute protection when the animals are exposed to heavy infection. If following vaccination and movement deaths continue to occur, a second inoculation should be given, but every effort should be made to reduce the degree of infection to which the stock are exposed.

When an outbreak of anthrax occurs in a milking herd, neither the milk nor the butterfat should be used. In many outbreaks the animals that die are not the only ones that become affected. Other cows may recover without showing any serious symptoms, and the milk of the herd is therefore potentially dangerous.

Blackquarter or Quarter Ill

Blackquarter is a specific infectious disease of cattle and sheep caused by the organism *Clostridium Chauvoei*. This organism belongs to a group of bacteria which are called anaerobes, because they can be grown in culture only in the absence of oxygen. *Clostridium Chauvoei, C. septicum* and *C. Welchii,* along with a number of others, produce on subcutaneous inoculation a condition known as "gas gangrene", that is to say, when they multiply under the skin they produce quantities of gases and cause necrosis of the underlying tissues with swelling and other signs of inflammation.

Blackquarter is most frequently observed in cattle, but sheep may become infected at shearing or lambing. Horses, dogs and man do not suffer from true blackquarter, but these species as well as the pig and the ruminants may develop clinically indistinguishable lesions caused by other Clostridia; for example, *C. septicum,* the condition usually being termed malignant œdema.

The usual method of infection in true bovine blackquarter is probably by ingestion, but this point has not been proved experimentally.

Occurrence.—On the majority of infected farms, blackquarter only occurs in cattle between the ages of six months and two years. There are, however, in Kenya a number of farms where infection is so heavy that cases may occur in fully mature animals.

In sheep the disease is usually seen only during the first week after shearing, and cases may occur in shorn sheep of any age. Ewes occasionally develop the disease from infection of the vulva through injuries sustained during lambing.

Symptoms.—In cattle the disease develops very rapidly and most frequently the animal is found dead with a puffy swelling on one of the quarters without any premonitory symptoms having been observed.

When seen in the early stages the animal is dull, ceases to feed and ruminate, and stands apart from the others with the head depressed. The respirations are accelerated, and when forced to move the animal is noticed to be very lame. There is a marked rise in temperature. On feeling the lame leg, a swelling will be found in the upper portion. This swelling is very hot, painful, and crepitates or crackles on manipulation. It tends to spread rapidly and later becomes cold and painless.

The disease progresses rapidly; there is grunting and grinding of the teeth, great prostration and very marked lameness. Death occurs suddenly, and may be preceded by a bloodstained discharge from the bowels and nose.

In sheep, symptoms are rarely noticed, since the course is very rapid. In general they resemble those in cattle. The muscle lesions are, however, not so large and do not crepitate so much. As infection is usually contracted by shearing, lesions may occur at sites other than the upper parts of the limbs.

Period of Incubation.—This varies from two to five days. The course of the disease is usually 12 to 48 hours, but adult and partially immune cattle may live somewhat longer.

Post-mortem Lesions.—The appearance of the dead animal is very similar to that of an animal that has died of anthrax, and care should be taken to exclude the latter disease before cutting the carcass. Owing to the danger of spreading infection, a full post-mortem examination should not be made, particularly since a diagnosis usually presents little difficulty.

On cutting the lesion the muscles will be found blackened, dryish and full of cavities like a sponge. There is a characteristic smell of rancid butter, and the connective tissue is infiltrated with a bloodstained serous fluid.

All the internal organs are severely congested, and there may be bloodstained fluid in the heart sac and the chest and body cavities.

Diagnosis.—A blood smear and a smear from the affected muscle is usually sufficient to enable a diagnosis to be made. When vaccinated cattle die or when there is a possibility of an organism other than *C. Chauvoei* being responsible, a thin strip of muscle should be forwarded to the laboratory, packed in dry salt or alternatively dried in the sun whilst protected from flies, and despatched in a cigarette tin. This is necessary because it is practically impossible to differentiate the Clostridia microscopically.

Apart from anthrax, cases of snake-bite and hæmorrhagic septicæmia may be confused with blackquarter. Cases of so-called "snake-bite" in cattle are almost always cases of hæmorrhagic septicæmia. In this disease the local swelling, on cutting, will be found to be due to the accumulation of large quantities of straw-coloured gelatinous fluid and not to gas-filled blackened muscle. Swellings on the throat should not be cut, of course, until anthrax has been eliminated.

Control.—There is no remedial treatment, and carcasses should be burnt or buried deeply.

Remove the healthy cattle to clean land and vaccinate. On known infected land young stock should be vaccinated when about six months old, and on some farms in East Africa annual vaccination of all stock is essential.

Vaccination does not confer absolute protection, and vaccinated cattle may succumb to heavy infection. The vaccine is, moreover, only prepared with the true blackquarter organism, and it gives no protection against infection with other members of the group.

Entero-toxæmia

The term entero-toxæmia is applied to a group of diseases of sheep in which types of the anaerobic organism, *Clostridium Welchii*, multiply in the gut and produce powerful toxins. These toxins are absorbed into the circulation and so produce death.

Four types of *C. Welchii* are recognized, and are known as Types A, B, C and D. Type A is commonly found in the intestines and its toxin is not usually produced in sufficient quantity to cause any ill-effects. Type B produces at least five types of toxin, one being that produced by Type A. This type of organism is responsible for lamb dysentery, a disease which occurs amongst lambs on farms situated in the higher parts of Kenya Colony. Type C produces all but one of the toxins of Type B. It causes a disease known as "struck" in the Romney Marsh district of Kent. Type D produces two of the toxins of Type B, but not the highly lethal *B* toxin of B and C. This type causes pulpy kidney of lambs and weaners, a condition which also occurs at the higher altitudes in Kenya.

All forms of entero-toxæmia are restricted to young growing sheep which are in good condition, and it would appear that their occurrence is influenced by the amount and quality of food in the intestinal canal. Probably an overloaded bowel produces conditions highly favourable to the multiplication of *C. Welchii*. In a flock of lambs the incidence of pulpy kidney is always lower in twins than in singles, and mortality can often be reduced by driving the sheep about or by other measures liable to reduce the milk yield of the ewes.

In good seasons in parts of Laikipia a condition occurs amongst wethers which appears to be identical with the disease known as *geilsiekte* in South Africa. This disease only attacks the fattest of the flock, and is probably a form of entero-toxæmia, although so far only Type A organisms have been isolated.

Lamb Dysentery.—This disease affects lambs between the ages of three and fourteen days. It is characterized by prostration and the passage of dark, fluid fæces, usually containing blood. Death is rapid, and as in all forms of entero-toxæmia putrefaction occurs early.

On post-mortem examination patches of intense congestion occur in the small intestine,

and in a high percentage of cases the mucous membrane shows oval, grey ulcers in the congested areas. The liver is pale and swollen, and the kidneys are soft and congested. If the autopsy is delayed the kidneys may be half liquefied.

Pulpy Kidney.—This condition occurs in lambs three to four weeks of age and in weaners of three to four months, the latter age being probably the more common in Kenya. Death is usually sudden without any premonitory symptoms. On post-mortem examination it is usually difficult to find definite lesions. Rapid softening and even liquefaction of the kidneys occur after death, but whenever sudden deaths occur in animals of this age and the possibility of other diseases has been excluded, the presence of entero-toxæmia should be suspected. It is perhaps advisable to stress that entero-toxæmia never occurs in sheep in poor condition.

Diagnosis.—The presence of entero-toxæmia can only be proved by the demonstration of the toxins in the gut. The small gut should be stripped from the skirt and its contents squeezed out into a clean empty bottle. The contents should be shaken in the bottle to mix them and half then poured into a second bottle containing a few drops of chloroform as a preservative. (Bottles for the collection of material can be obtained from the Veterinary Research Laboratory, Kabete.) Both bottles should then be labelled and despatched to Kabete.

The preserved material is filtered to remove living bacteria, and then inoculated into the veins of mice. From the behaviour of the mice it is possible to tell if toxin is present and to get some idea of the type. If toxin is shown to be present, attempts are made to isolate the type responsible from the other bottle containing unpreserved material.

Control.—Prior to the introduction of immunization, the usual methods of control were movement to clean land, driving every day, and dosing with sulphur. Movement is still advisable, particularly in outbreaks of lamb dysentery.

Immunization is effected with a combined vaccine prepared from strains of Types B and D, and in this way the toxins of all the types are covered. Obviously, vaccination of newly born lambs cannot immunize early enough to prevent lamb dysentery. Fortunately, antitoxins are transferred from the mother to the young animal in the colostrum, and the procedure recommended is therefore to vaccinate the ewes three weeks and again one week before lambing is due to commence. In this way a passive immunity is induced in the lamb.

The passive nature of this immunity is, however, to be emphasized. On farms where both lamb dysentery and pulpy kidney occur, the immunity from the ewes' colostrum will not last sufficiently long to protect the three to four weeks' old lamb from pulpy kidney. It is necessary therefore to vaccinate the lambs themselves against the latter disease.

WORM NONSENSE

Not long ago there appeared in two reputable American publications accounts of a remarkable "earth-worm farm" and the wonders that a Dr. G. S. Oliver had achieved there. As particulars were being reproduced in this country, I made inquiry of the United States Department of Agriculture, which draws my attention to "a long, considerably apologetic letter from Dr. Oliver that appeared in (the American) *Nature* for February, 1941." "As to the alleged 'three-volume work, *Our Friend the Earthworm*'," the letter with which I am kindly favoured continues, "we searched both the Library of Congress and that of the Department in vain and found that no one in official Washington had ever seen it! I have known personally of Dr. Oliver for some years as the proprietor of the 'California Earthworm Farms', and have before me advertising literature issued over his signature, making absurd and extravagant claims for the soil-building virtues of his product. But a very important point which has not been revealed by him or by the articles above cited, is that earthworms subsist on the organic matter in the soil. They consume it in comparatively large quantities, and do not create it as claimed by Dr. Oliver. Darwin's work showed that their principal benefits to the soil consisted in the comminution of the subsoil, the deposition of this on the surface, and the facilitating of aeration and permeability of the soils inhabited by them. One can scarcely avoid the conclusion that the two reputable periodicals cited were made the innocent victims of what is known here as 'an advertising racket'."

The Countryman

THE EAST AFRICAN AGRICULTURAL JOURNAL

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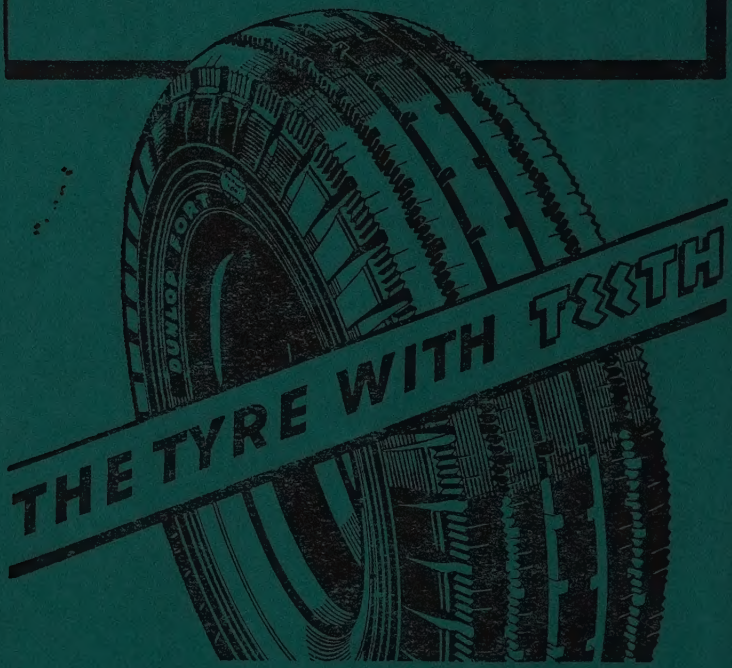

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